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# ILLINOIS TECHNOGRAPH

JANUARY, 1956 .25

**Edward J. Stolic, class of '48**
**speaks from experience when he says . . .**

# "With U. S. Steel, my future holds interest, challenge and reward."

From his graduation in 1948 with a B.S. degree in Mechanical Engineering, until November of that year, Edward Stolic worked as an operating trainee in the Irvin Works of United States Steel. Following his discharge from the Army in 1950, he returned to work at U.S. Steel. In just 18 months, Mr. Stolic reached a management position as Engineer-Lubrication.

By mid-year 1953, Mr. Stolic was promoted to Foreman-Instrument Repair and Sub-Station. In a recent interview he said: "Opportunities for rapid advancement are almost limitless in U.S. Steel." At 27, Mr. Stolic is supervising a force of 30 men in mechanical and electrical tests as well as instrument repair and maintenance of gas generators, compressors and water purification units. He feels that, "The engineer finds many places to apply the knowledge he garnered in school." The men under Edward Stolic are called on to trouble shoot in any part of the mill. This calls for a wide variety of talents and leads Mr. Stolic to say: "The steel industry has expanded greatly, and with it the need for good men."

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6-02

# *Industry and Education —*

A simmering controversy broke out into an open boil early last month which led to the resignation of five members of the administration and finally the director of the Northwestern University Technological Institute.

At first, the only source of information as to why they had resigned came via rumor. "It was said" the controversy had been between the five and the director over applied and pure research, one side holding for emphasis on the former, while the director wished to emphasize the latter.

The final story was revealed in a Chicago newspaper and it is this which is of interest to engineers and engineering schools.

In 1939, Walter P. Murphy, manufacture of railway parts, was looking for an educational institute to endow. He wanted to find an institution which would, under the terms of his grants, send students to work half-time in industry while attending school.

Northwestern University's Technological Institute accepted these terms and was built at a cost of six million dollars. In 1942, following Murphy's death, the Institute received 25 million dollars more, under the required "co-op" stipend.

The controversy came as to whether this program should be literally followed. Some faculty members felt that many students didn't get sufficient knowledge from their commercial assignments, contending they were routine and minor and the students would learn more from class room activity. The five members of the administration disagreed and resigned.

The co-op program is relatively new in colleges. It has advantages in that the student can earn money for school while working in his chosen field. Working this way, he may receive valuable experience, yet the same work can be done by voluntary college placement services and the student finishes college in four, not five years.

For the co-op program to be required by a school seems somewhat unreasonable. For the program to be required under the terms of an endowment to the school is even more so. It is all right to establish scholarships with such conditions, but the attempt to guide the policies of a school for years to come seems unreasonable and unjustifiable.

H. R. H.

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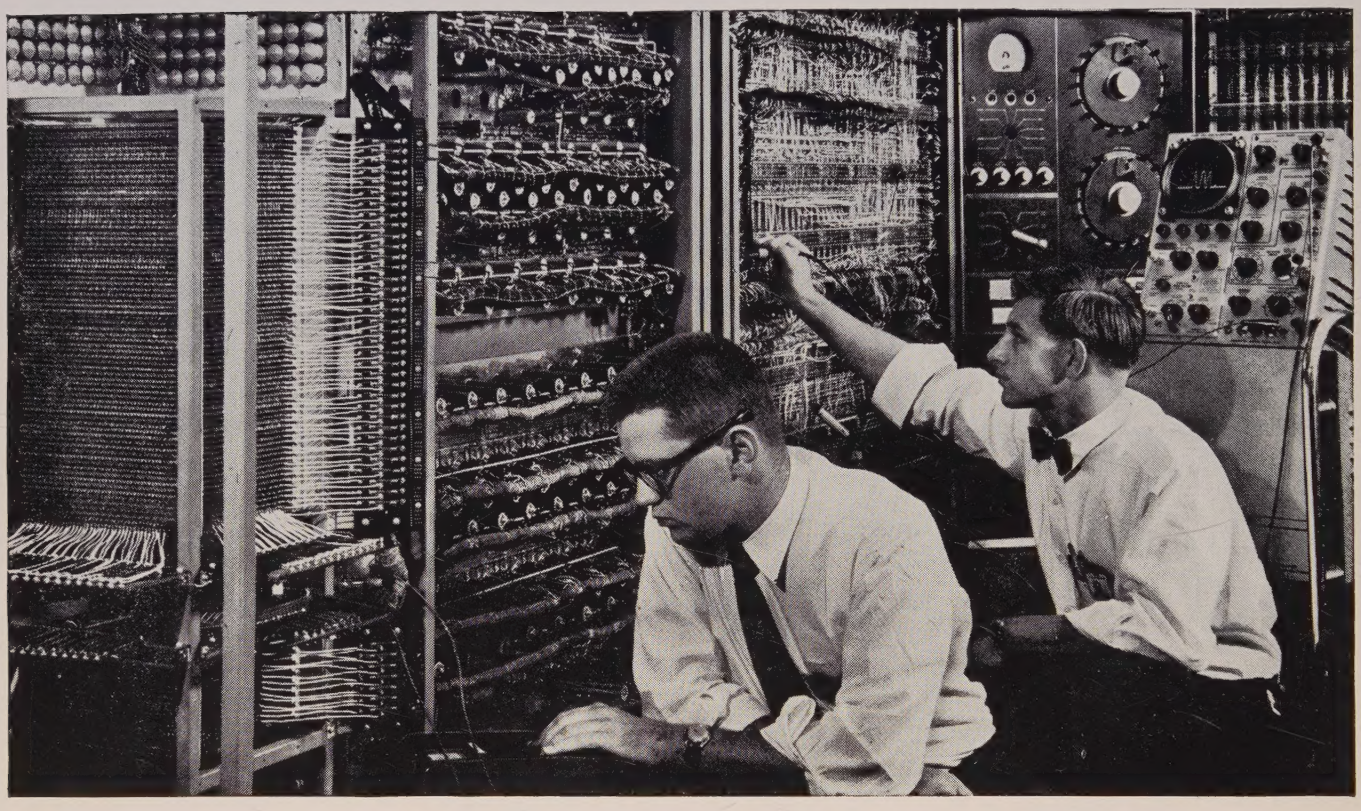

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# THE ILLINOIS TECHNOGRAPH

**Volume 71** **Number 4**

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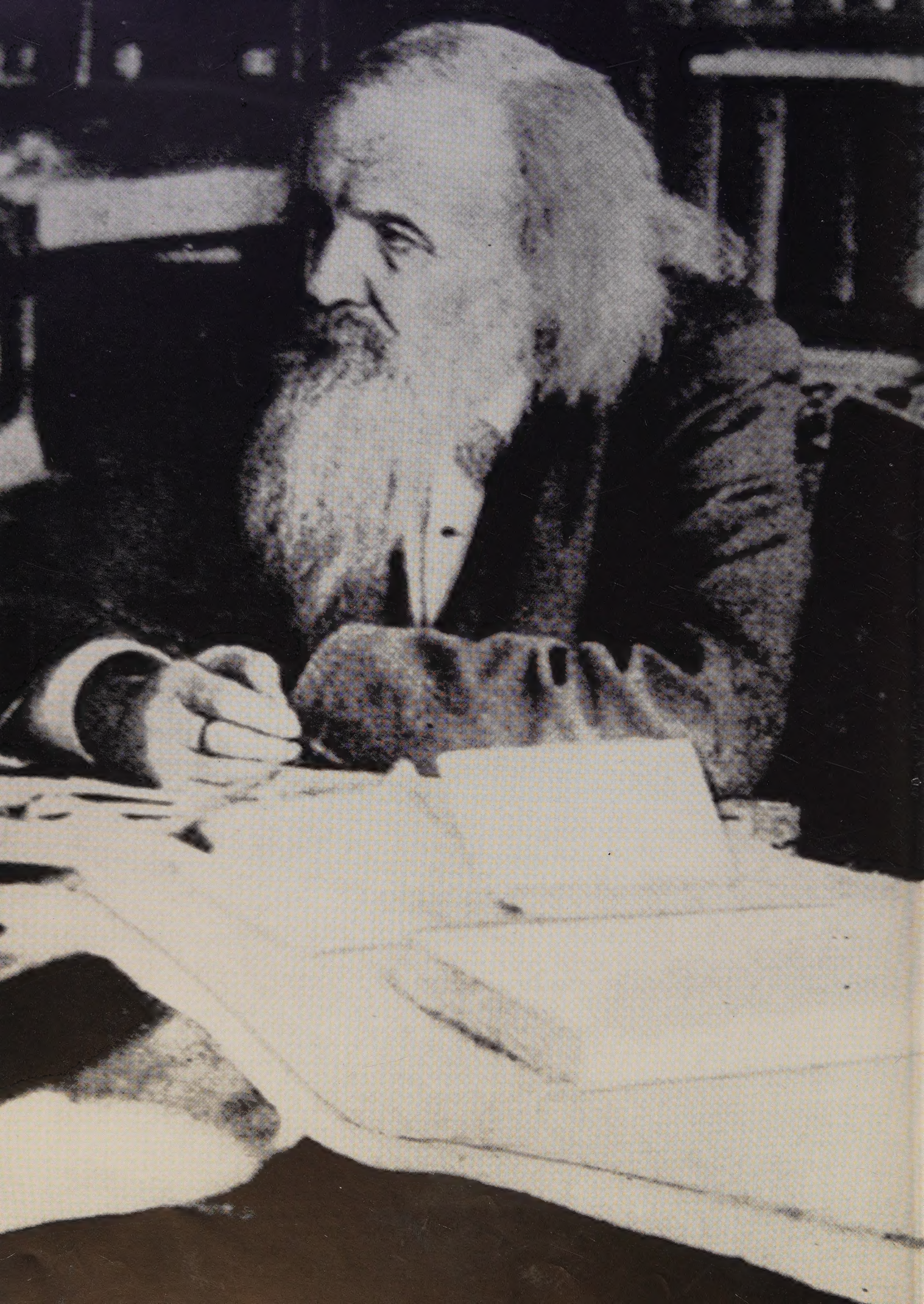
## *Our Cover*

Acres upon acres of bright, color-coated pipelines and beyond them the functionally majestic forms of chemical processing units abuilding. So does Stanley Meltzoff symbolize the genius of the second half of the 20th Century—the Age of Plenty Through Chemistry. United Engineers & Constructors, Inc. of Philadelphia, Chicago, and New York furnished the coverplates for our cover.

## *Our Frontispiece*

The man responsible for the wonders of modern chemistry through his studies of the periodic system seemed like a Biblical sage in his study—Dmitri Mendeleyev.



*Atomic Genius . . .*

# MENDELEYEV

by Harry Hirsch, E. E. '57

"Mendeleyev? Oh, he developed the periodic table of the elements .

"How do you spell his name? Let's see, Mendeleeff, no, Mendelejeff, no, Mendeleyef?

"What else did he do? I dunno."

Any student can easily answer the first question: who was Mendeleyev? The second question: how to spell the great scientist's name, is somewhat more difficult. (All four are accepted.) But it is the third question: what else did he do, what sort of man was he, on which everyone fails.

The truth of the matter is that little material exists on Mendeleyev (we've decided to stick to one spelling from now on) the man. The only full-scale biography of him is a fictionalized account of his life by Daniel Q. Posin, called "Mendeleyev, the Story of a Great Scientist." Other sources of information on Mendeleyev's life are brief notations in encyclopedias and anthologies of the lives of great scientists.

Among the accounts of his life are found many variances. It is agreed by all, however that he was born Feb. 7, 1834, at Tobolsk, in Siberia, the youngest of a family of 17 or 14, depending on what account you read. How is father Ivan Pavlovitsch Mendeleyev, a former student at the Chief Pedagogic Institute at St. Petersburg, was Director of the Gymnasium (secondary school) in Tobolsk. He had originally taken the post in Tobolsk and married Maria Dmitrievna Kornileff, whose family had been pioneers in that region. Later, the elder Mendeleyev took posts further west in Russia, at Tambov and Saratov, but at the insistence of his wife, returned to Tobolsk.

Dmitri was born shortly after his family's return. Just after his birth, his father began to gradually grow blind from cataracts of both eyes and had to retire on a pension of 1,000 rubles (500 dollars) per year.

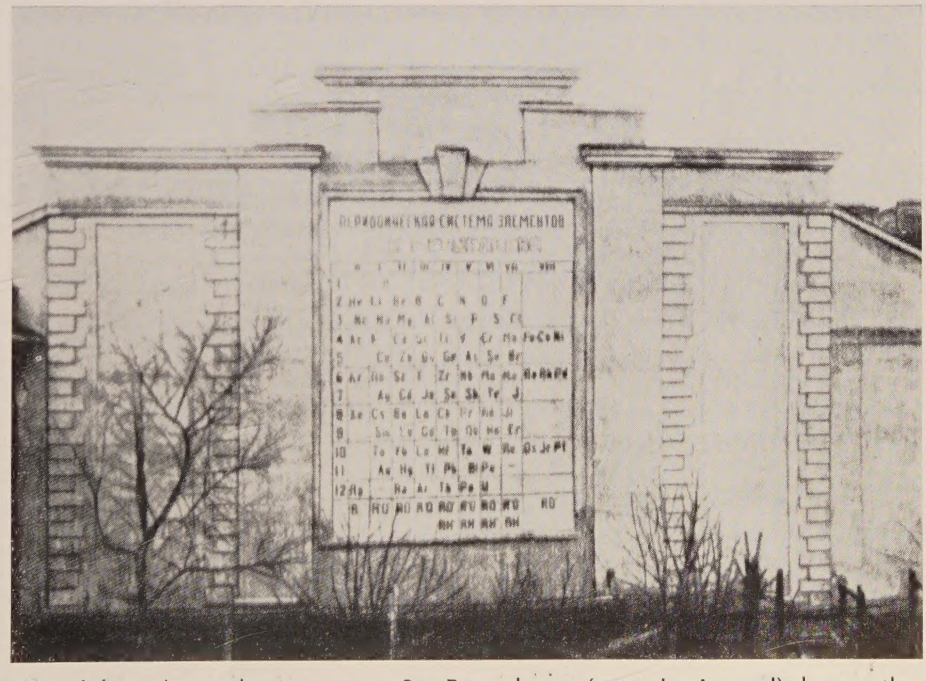
The care of the family fell on Maria Dmitrievna's shoulders. Her family had been the first to manufacture paper and glass in Siberia and she revived the family glassworks to support her husband and children until her husband's death of consumption in 1847. One story says that it was here that little Dmitri acquired his interest in the natural sciences, watching the blue, green and violet colors of the chromium, cobalt and manganese oxides used in the glassworks. Another story tells that his interest in the sciences came about from the influence of the many exiles called "Decemberists" who had been sent to that rugged outpost. One of them had married his sister Olga and supposedly sparked the interest in natural sciences in Dmitri.

Dmitri's mother had always been interested in higher education. In her youth, denied the advantages of formal schooling, she learned her lessons from her brother's books and later constantly encouraged her children in the pursuit of knowledge. On the death of her husband in 1847, Mme. Mendeleyev took Dmitri and one of his sisters, Elizabeth, to Moscow to enter Dmitri at the University there. Disappointed in this wish, the trio went to St. Petersburg in 1850. There, with the aid of Pletnoff, the director of the Chief Pedagogic Institute, an old friend of Dmitri's father, Dmitri was able to start his formal higher education.

While studying at St. Petersburg, Dmitri's health failed and his mother, strained by the work she had done to support her family, died. Her final words to the young student were, "Refrain from illusions, insist on work and not on words. Patiently seek divine and scientific truth."

On the death of his mother, Dmitri went to Simferopol in the Crimea as chief science instructor at a school there. His health improved, he taught physics and mathematics in Odessa, returning to St. Petersburg in 1856. He then studied at Paris and Heidelberg, concentrating on investigating the physical properties of liquids, especially their expansion by heat. In 1866, he was appointed professor of general chemistry at the University at St. Petersburg.

Mendeleyev married Ana Lestshoff in 1863. Although they had two children, Vladimar and Olga, they were incompatible and separated, later to divorce. In 1881, he remarried, this time to a young lady artist, Anna Ivanovna



Mendeleyev's tombstone near St. Petersburg (now Leningrad) bears the periodic table on its face. (McGraw-Hill Book Co., Inc.)

Popova, who did much to shape his artistic and other non-scientific tastes. They had four children, Lioubov, Ivan, Maria and Vassili.

During this time, Mendeleyev was studying the nature of solutions. He treated them as homogenous liquid systems of unstable disassociating compounds of the solvent with the substance dissolved. He investigated the thermal expansion of liquids and derived a formula for its expression, anticipating the conception of the critical temperature of a gaseous substance as the temperature at which cohesion and heat of vaporization become equal to zero and the liquid changes to vapor irrespective of pressure and volume. He also studied the nature of the origins of petroleum and luminifeous ether, traveling to the Pennsylvania oil fields in 1876 to investigate their workings in an effort to deal with the problems of refining and drilling in the Caspian Sea oil resources of Russia.

In 1868, he wrote his famous text, "Principles of Chemistry" which was a mark of his ability as a great teacher. It had an immense influence on the distribution of views concerning elements and their relation to one another.

The discovery for which he is most famous was first published in 1869, when he postulated his periodic law for the elements, treating their periodic relation as a law of nature. He was lead by the gaps in his tables to assert the existence of three new elements and assign them and their compounds certain properties. The discoveries of Gallium in 1871, Scandium in 1879, and Germanium in 1886 bore out his theories. He also questioned the correctness of certain heretofore accepted atomic weights. He was the first to formulate a general law connecting atomic weights with properties and to indicate the character of such a law and foretell properties of undiscovered elements and alter accepted atomic weights by the use of this law.

During this time, Mendeleyev lived the life not only of a scientist, but of a man interested in his surroundings. His views on education caused him much enmity as he was a foe of the accepted classical education, claiming that no Platos were needed but dozens of Newtons were. He believed that education would be the best way of attaining universal peace if it was a "realistic" education. He desired a religion which subordinated the individual to the general good will. As a social progressive, he was sympathetic to the cause of women, employing some, while recognizing their limitations in certain fields and always speaking up for their rights.

He scorned the theatre as a frivolous waste of time while loving art and reading. His favorite authors included the light books of James Fenimore Cooper and Jules Verne, as well as the weightier tomes represented by Shakespeare, Schiller, Goethe, Hugo, Lord Byron and the Russian classicists Pushkin, Zhoucovsky, Miacoff and Tuttcheff. He was labeled as somewhat of an eccentric because of his informal style of dress and rare haircuts. Indeed it was said that he had his hair cut and beard trimmed once a year by a former sheepshearer and refused to dress formally in an audience with the Czar. It is known that he shunned uniforms and never wore the many decorations and medals he had been awarded.

As a teacher, Mendeleyev was acclaimed as one of the greatest of his time. One of his students said, "Many of them, (students), I am afraid, could not follow Mendeleyev, but for the few of us who could, it was a stimulant to the intellect and a lesson in scientific thinking which must have left deep traces on their development." He was always ready to take the students' side in a dispute with the administration and this ultimately led to his resignation from the University in 1890. He had earlier pacified a heated mob of students who had a grievance with the adminis-

**MODERN PERIODIC TABLE**

***The number of electrons in filled shells is shown in the column at the extreme left; the remaining electrons for each element are shown below the symbol and atomic number for each element. The atomic weight is shown above the symbol.***

| SERIES | "LIGHT" METALS IA — Alkali Metals | "LIGHT" METALS IIA — Alkaline Earth Metals | HEAVY METALS — BRITTLE IIIB | IVB | VB | VIB | VIIB | DUCTILE VIII | | | IB | LOW MELTING IIB | NONMETALS IIIA | IVA | VA | VIA | VIIA | INERT GASES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 1.0080 H[1] 1 | | | | | | | | | | 4.003 He[2] 2 |
| 2 | 6.940 Li[3] 1 | 9.013 Be[4] 2 | | | | | | | | | | | 10.82 B[5] 3 | 12.010 C[6] 4 | 14.008 N[7] 5 | 16.0000 O[8] 6 | 19.00 F[9] 7 | 20.183 Ne[10] 8 |
| 3 2,8 | 22.997 Na[11] 1 | 24.32 Mg[12] 2 | | | | | | | | | | | 26.97 Al[13] 3 | 28.06 Si[14] 4 | 30.98 P[15] 5 | 32.066 S[16] 6 | 35.457 Cl[17] 7 | 39.944 A[18] 8 |
| 4 2,8 | 39.096 K[19] 8,1 | 40.08 Ca[20] 8,2 | 45.10 Sc[21] 9,2 | 47.90 Ti[22] 10,2 | 50.95 V[23] 11,2 | 52.01 Cr[24] 13,1 | 54.93 Mn[25] 13,2 | 55.85 Fe[26] 14,2 | 58.94 Co[27] 15,2 | 58.69 Ni[28] 16,2 | 63.54 Cu[29] 18,1 | 65.38 Zn[30] 18,2 | 69.72 Ga[31] 18,3 | 72.60 Ge[32] 18,4 | 74.91 As[33] 18,5 | 78.96 Se[34] 18,6 | 79.916 Br[35] 18,7 | 83.7 Kr[36] 18,8 |
| 5 2,8,18 | 85.48 Rb[37] 8,1 | 87.63 Sr[38] 8,2 | 88.92 Y[39] 9,2 | 91.22 Zr[40] 10,2 | 92.91 Cb[41] 12,1 | 95.95 Mo[42] 13,1 | 99 Tc[43] 13,2 | 101.7 Ru[44] 15,1 | 102.91 Rh[45] 16,1 | 106.7 Pd[46] 18 | 107.880 Ag[47] 18,1 | 112.41 Cd[48] 18,2 | 114.76 In[49] 18,3 | 118.70 Sn[50] 18,4 | 121.76 Sb[51] 18,5 | 127.61 Te[52] 18,6 | 126.92 I[53] 18,7 | 131.3 Xe[54] 18,8 |
| 6 2,8,18 | 132.91 Cs[55] 18,8,1 | 137.36 Ba[56] 18,8,2 | [57-71] * Rare Earths | 178.6 Hf[72] 32,10,2 | 180.88 Ta[73] 32,11,2 | 183.92 W[74] 32,12,2 | 186.31 Re[75] 32,13,2 | 190.2 Os[76] 32,14,2 | 193.1 Ir[77] 32,17 | 195.23 Pt[78] 32,17,1 | 197.2 Au[79] 32,18,1 | 200.61 Hg[80] 32,18,2 | 204.39 Tl[81] 32,18,3 | 207.21 Pb[82] 32,18,4 | 209.00 Bi[83] 32,18,5 | 210 Po[84] 32,18,6 | 211 At[85] 32,18,7 | 222 Rn[86] 32,18,8 |
| 7 2,8,18,32 | 223 Fr[87] 18,8,1 | 226.05 Ra[88] 18,8,2 | 227 Ac[89] 18,9,2 | 232.12 Th[90] 18,10,2 | 231 Pa[91] 18,11,2 | 238.07 U[92] 18,12,2 | 237 Np[93] | 239 Pu[94] | 241 Am[95] | 242 Cm[96] | 243 Bk[97] | 244 Cf[98] | | | | | | |
| * | | | 138.92 La[57] 18,9,2 | 140.13 Ce[58] 19,9,2 | 140.92 Pr[59] 20,9,2 | 144.27 Nd[60] 21,9,2 | 146 ± Il[61] † 22,9,2 | 150.43 Sm[62] 23,9,2 | 152.0 Eu[63] 24,9,2 | 156.9 Gd[64] 25,9,2 | 159.2 Tb[65] 26,9,2 | 162.46 Dy[66] 27,9,2 | 164.94 Ho[67] 28,9,2 | 167.2 Er[68] 29,9,2 | 169.4 Tm[69] 30,9,2 | 173.04 Yb[70] 31,9,2 | 174.99 Lu[71] 32,9,2 | |

† The names Cyclonium and Promethium have been suggested for the synthetic form of element 61.

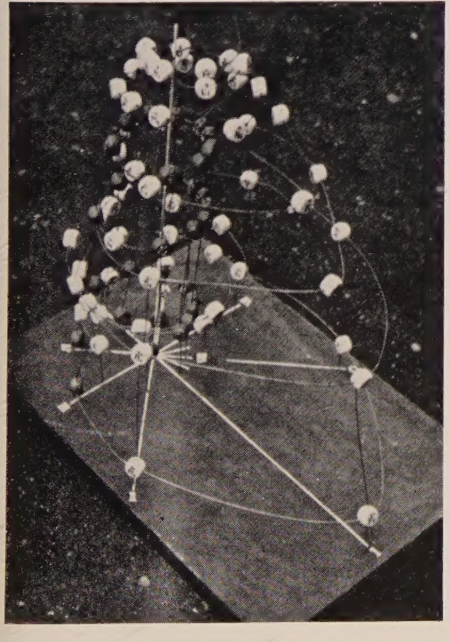
This "rectangular" type table is based not on Mendeleyev's basis of atomic weight, but the modern concept derived from quantum theory of the atomic number of an element.

tration by promising to present their side to the Minister of Education. Instead of being acclaimed for this by the authorities, he was rebuked for butting in. This and the enmity resulting from his unpopular views on education led to his resignation. From 1893 until his death in 1907, he was director of the Bureau of Weights and Measures in St. Petersburg.

In 1887, as an observer at a solar eclipse, he went through an interesting experience. He and an assistant were to climb to the upper atmosphere in a hydrogen-filled balloon to observe the eclipse's effect there. His assistant got out to lighten the load and Mendeleyev, who had no previous navigational experience, sailed away. He climbed to 11,375 feet and traveled 150 miles before alighting before an astonished group of peasants, unharmed and in good spirits.

In 1882, he received the Davy Medal of the Royal Society of England, being named an Honorary Member of the Chemical Society in 1883, and Foreign Member of the Royal Society in 1890. He received a second award, the Copley Medal, from the Royal Society in 1903. Curiously, he was never named to the Imperial Academy of Sciences at St. Petersburg. Sir William A. Tilden, in his book on famous chemists, said it was indeed remarkable the things Mendeleyav accomplished, considering the fact that he was living under the terroristic regime of Czarist Russia.

Early in 1907, Mendeleyev caught a cold and weakened by an earlier influenza attack suffered an inflammation of the lungs. He died shortly after and was buried in Volkovo cemetery in St. Petersburg. A tablet inscribed with the periodic system marks his grave.



*The Origin of . . .*

# THE PERIODIC TABLE

by Harry Hirsch, E. E. '57

The periodic system of the elements was not just something Mendeleyev concocted spontaneously out of his head. Prior to his studies, there existed a long history of the attempts of scientists to develop some sort of comprehensive atomic theory. Lavoisier's "Elements of Chemistry," Dalton's "A New System of Chemical Philosophy," Gay-Lussac's "On the Combination of Gaseous Substances," Avogadro's "On the Relative Masses of Elementary Molecules," and Cannizzaro's "A Course of Chemical Philosophy," were milestones in this long line of research. It was the work of these men and many others that laid the groundwork for Mendeleyev's eventual statement of the laws governing the interrelations among the elements.

Dalton advanced the theory that compounds of bodies were formed by an atom of one uniting with one, two, three or more of another substance; that is, they formed in exact constant proportions. Gay-Lussac went on to say that gases combine with one another in very simple ratios by volume. Avogadro spoke of the division of heretofore believed indivisible molecules. Cannizzaro wrote of equal volumes of gases containing equal numbers of molecules but not atoms. He said the weights of molecules were proportional to their vapor densities. He postulated the theory of the atom when he said, "The different quantities of the same elements contained in different molecules are all whole multiples of one and the same quantity, which, always being entire, has the right to be called an atom." This was a new development in atomic theory which had once called what we know as molecules, atoms. He also supposed some type of relationship between the atoms and their weights when he found that by putting the known atoms in a list by their weights, the properties of every eighth atom, no matter where one started, was similar to the eighth ahead of it or behind it. He did not, however, further develop this theory.

Mendeleyev, when he began his studies, first examined and rejected all previous schemes that had been proposed to classify the elements. Among them was a classification of elements into metals and non-metals. This method, based on one physical difference, lost its value with the discovery of elements such as phosphorus which exhibited both metallic and non-metallic properties. Systems based on the behavior of elements with respect to hydrogen and oxygen showed many uncertainties, separating elements that otherwise showed great similarity to each other. Iodine and fluorine were distinguished by the fact that the former easily forms compounds with oxygen and rarely combines with hydrogen. The latter, displaces oxygen and forms very stable compounds with hydrogen. The ordering of elements according to electrochemical sequence and according to relative resemblances were likewise rejected. Later, chemists tried to achieve order on the basis of the valency of elements. Many uncertainties were found since some elements of the same group formed compounds with different valences. Other elements such as manganese and aluminum had valences that were nearly impossible to determine.

Thus at the time Mendeleyev was conducting his studies, no strict classification had been found for the 60-odd elements that were then known to exist. There was no one single universal guiding principle that could withstand scientific criticism and serve as a guide to

←

In this space model, the atomic weight is taken on a vertical axis and the atomic volume on a horizonal axis.

judge the relative properties of elements and permit their arrangement in a universal system. Groups of elements, of which there was no doubt of their relations to one another were known to exist. Such groups were the halogens (F, Cl, Br, I), the alkaline earth metals, (Ca, Sr, Ba), the nitrogen group, (N, P, As, Sb, Bi), and partially the sulphur group.

The discovery of new elements such as rubidium, cesium and thallium gave rise to the reflection that the limited knowledge of elements and any attempt to construct a system appeared premature so long as no hypothetical basis on which to base the development and discovery of new elements was available.

Mendeleyev then began studying the relations of the atomic weights of elements to their properties. He pointed out that others had tried to establish relations based on this factor. One unsuccessful method had been to classify the elements into triads. The weight of the second element in the group equaled one-half the sum of the weights of the first and third elements. In this system, the natural grouping of the elements were often subjugated to the triads which scarcely corresponded to nature. Spaces were not left in this system to accommodate elements which might still be discovered.

Mendeleyev wrote when he started to formulate his chemical handbook entitled "Foundations of Chemistry" that he had to make a decision in favor of some system of elements in order not to be guided in their classification by accident, or instinctive reasons, but by some exact definite principle. A system based on numerical relations was to be preferred to others because it left little margin for arbitrariness. Something was to be followed which remained constant no matter what the state of the atom. This was the atomic weight.

The magnitude of the atomic weight is a quantity which does not refer to the momentary state of an element, but belongs to a material part of it, a part which it has in common with the free element and with all of its compounds. In his first attempt, he selected the elements of smallest atomic weight and ordered them according to increasing weight magnitudes. There appeared to be a periodicity of properties. He then set up a system by which the atomic weight of the element determined its place in the classification. The popular story is that he wrote the properties of known elements on cards and shuffled them about until the periodicity was found. Groups that were known to exist naturally, like the halogens, were placed in the classification according to their atomic weights. The natural similarity was not contradicted, but emphasized in the periodic system. Some discontinuities were found for elements not yet discovered and for others whose atomic weights were not accurately known.

In his initial paper on the subject, Mendeleyev summed up his findings as follows:

"1. The elements, if arranged according to their atomic weights, show a distinct periodicity of their properties.

"2. Elements exhibiting similarities in their chemical behavior have atomic weights which are approximately equal, (Pt, Ir, Os), or they possess atomic weights which increase in a uniform manner, (K, Rb, Cs).

"3. The arrangement of elements or

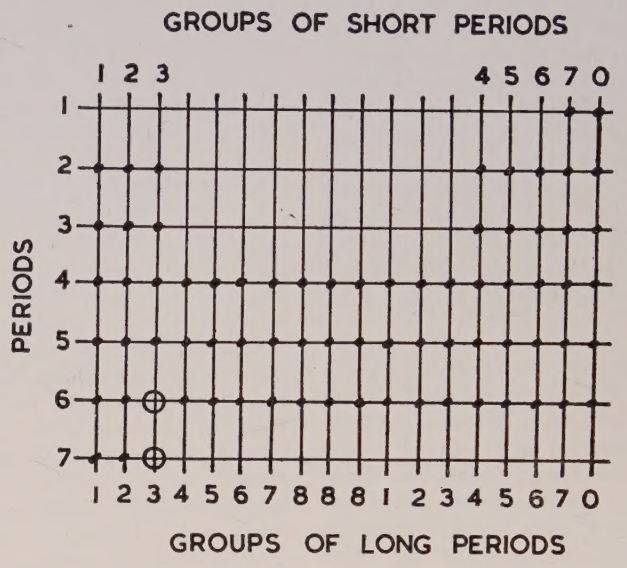
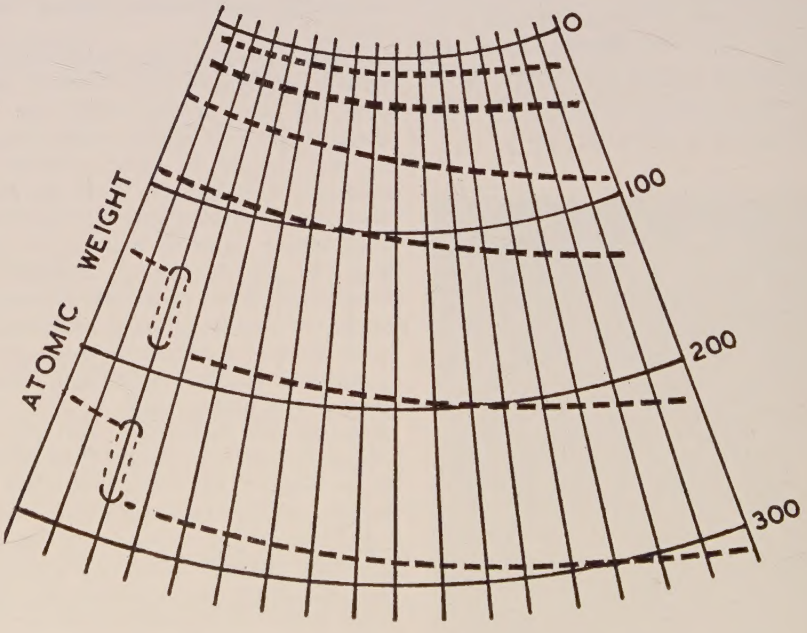
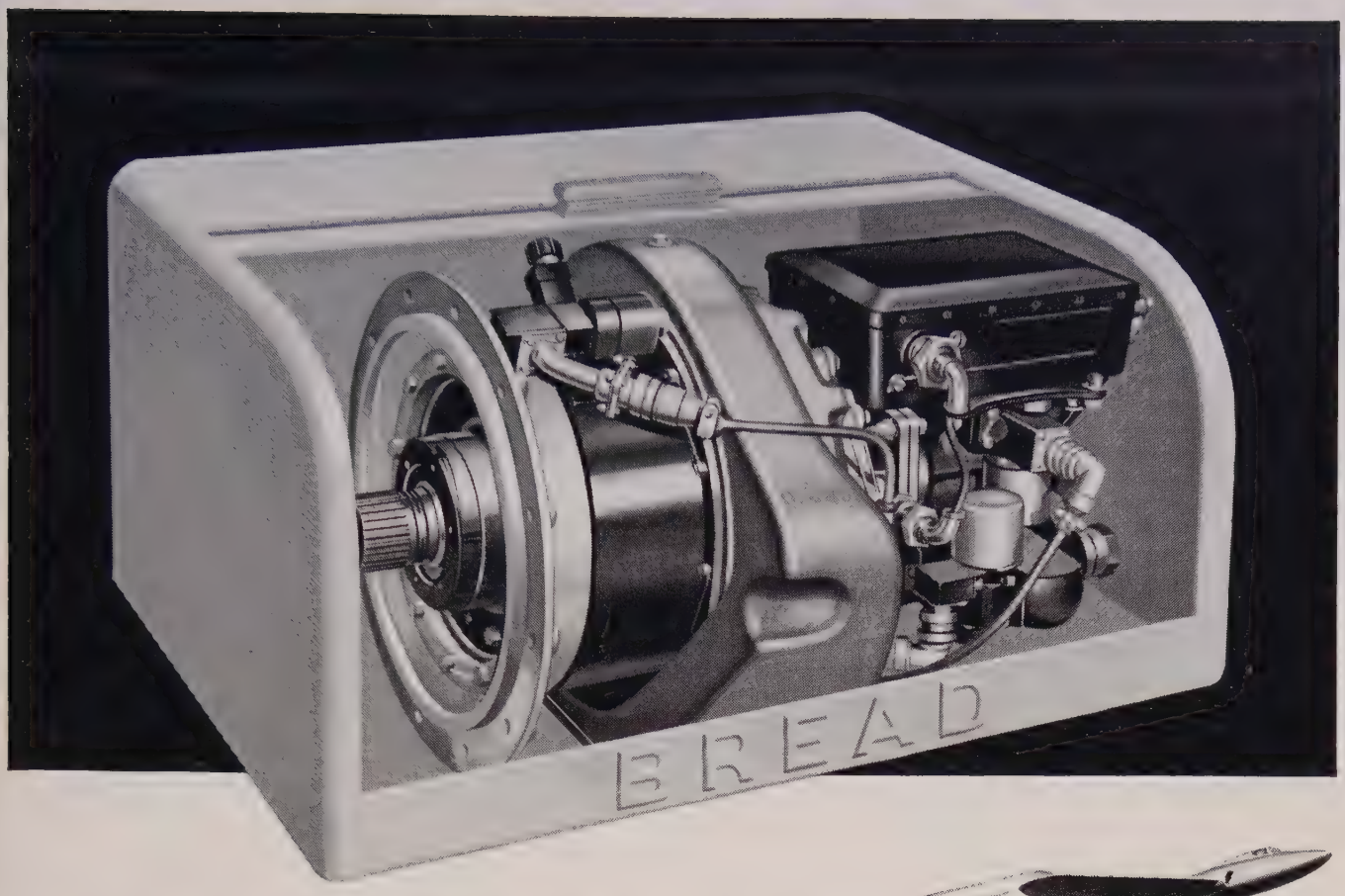



FIG. 1—"Long chart" rectilinear periodic table.

FIG. 2 (*below*)—"Long chart" rectilinear periodic table distorted to a "fan-shaped" or "open-cone" table, in which the atomic weight is plotted along the generating radius.




Under this outline "sketch" of the periodic table, there are gaps, yet no place is provided for the "rare earths." In fig. 2, the spreading of the 2nd and 3rd periods fills the gaps and allows for the "rare earths" groups.




# MORE POWER IN A SMALLER PACKAGE!

## How Bendix Engineers are Helping Lick the Aircraft Industry's No. 1 Problem

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This is but one example of how young Bendix engineers are working to solve the most severe problem plaguing the men who build today's (and tomorrow's) aircraft. Jet aircraft requirements call for more and more power in every new design. But with additional complex apparatus being jammed into every new plane that comes off the drawing board, extra power must be achieved without extra bulk. In fact, it is usually necessary to produce more power in a *smaller* package. That's when engineering skill which appreciates a real challenge comes to the fore.

Bendix is constantly seeking to increase its supply of this type of engineering skill. That's why the greatest opportunities in the world for talented young engineering graduates are found at Bendix Aviation Corporation. No matter what his field, the engineer with ability is assured of ample opportunity to demonstrate it at Bendix.

Bendix is in more businesses than aviation—many, many more. Producing over a thousand different products for just about every phase of industry, Bendix deserves your attention when you plan your engineering future. See your placement director or send for the brochure "Bendix and Your Future" for a full-scale look at what Bendix has to offer you. BENDIX AVIATION CORPORATION, FISHER BUILDING, DETROIT 2, MICHIGAN.

THE NAME Bendix AVIATION CORPORATION MILLIONS TRUST

of groups of elements according to their atomic weights corresponds to their valences, as well as their distinctive chemical properties.

"4. The bodies most abundantly found in nature possess small atomic weights; but all elements of small atomic weight are characterized by their distinct properties and are therefore 'typical' elements. Hydrogen, being the lightest is the most 'typical' of all.

"5. The magnitude of the atomic weight determines the character of the element.

"6. The discovery of numerous unknown elements is still to be expected.

"7. The atomic weight of an element will have to be corrected, eventually when its analogues are known." (Tellurium at this time was thought to have an atomic weight of 123 - 126. Its weight was later correctly determined as 127.61 and it matched its position in the periodic table.)

Today, the periodic system of the elements has been classed the most perfect and most comprehensive system of classification in the world. Its perfection comes from its being based on the internal structure of the atom, yet covering likewise its outward characteristics. Its comprehensiveness comes from its embracing all the existing building blocks out of which man, animals, plants, the earth and universe are made.

Mendeleyev's rectangular table is the most generally used and recognized but others exist. A. E. Begueyer de Chancourtois in 1862 arranged the elements in order of their atomic weights along the line of a cylindrical helix and found there was a resemblance between some of the elements situated along the vertical lines of the cylinder. In the same year that Mendeleyev made public his discovery, Lothar Meyer, in Germany published a similar version, consisting of a rectilinear network with rows and columns corresponding respectively to periods and groups. In 1870, H. Baumhauer proposed a spiral table. All these systems were based on the atomic weights of elements, which with the introduction of quantum theory were shown to be resultants of the mixture of component isotopes of the element. With the discovery of quantum theory, the atomic number of the atom became its fundamental dimension. Today's atomic table is built with the short or subperiods determined by the core of the nuclear shell and inner shell electrons, while the groups are determined by the perisphere or outer, planetary electrons which are easily detachable.

The periodic table of today possess continuity, periodicity, visibility and an image of the atom. The three basic types are still in use: rectilinear, helical and spiral. The rectilinear type has two subheadings. One is the "long" type with 18 vertical columns, while the "short" type has 8 and does not accurately visualize the quantum theory of atomic structure due to its telescopic nature. Due to its blockiness, the rectilinear type of periodic table lacks continuity, but possesses the complete visibility lacking in the helical type. The spiral type alone possess all four types of qualities.

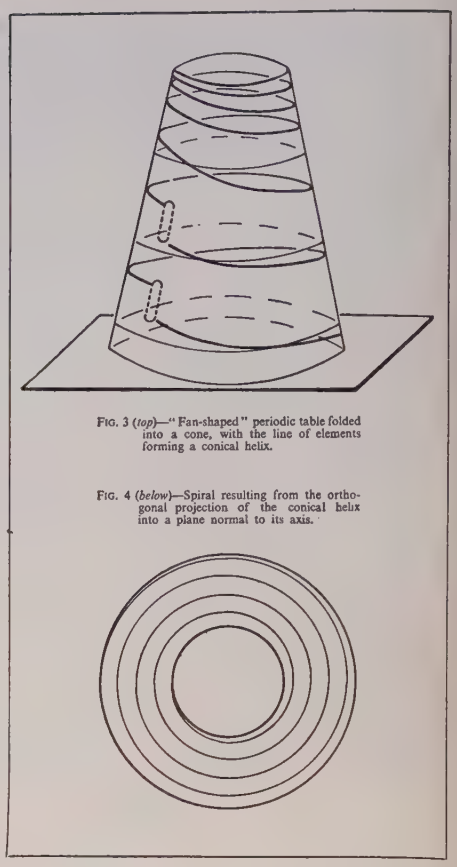

FIG. 3 (*top*)—"Fan-shaped" periodic table folded into a cone, with the line of elements forming a conical helix.

FIG. 4 (*below*)—Spiral resulting from the orthogonal projection of the conical helix into a plane normal to its axis.

**Fig. 3 is a fan shaped table folded into a cone with bad visibility features. Fig. 4 shows the orthogonal projection of the conical helix into a spiral with the four qualities of continuity, visibility, periodicity and image of the atom present.**

The latest tribute to the genius of Mendeleyev came this summer when scientists at the University of California produced 17 atoms of element 101, called Mendelevium (Mv). They had bombarded artifical element 99 with energetic alpha particles from a cyclotron. The particular isotope found had an atomic weight of 256 and spontaneous fission gave it a half life of between one-half and several hours. It resembles the rare earth Thalium. Many of these qualities could have been foretold by Mendeleyev himself when he first formulated his table. Perhaps this element will be placed on the table that marks Mendeleyev's grave.

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Saran Wrap is stretched by injecting compressed air to form a bubble ½ mil in thickness which is then compressed and wound.

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**Dow engineers create modern new plant for Saran Wrap production**

Demand was multiplying for Saran Wrap,* the clear moistureproof plastic wrap for foods. A new plant was needed . . . and needed fast.

Dow's engineering and technical staff went to work. Production processes were checked and improved. Mechanical engineers designed new machinery. Electrical engineers introduced new fluorescent lighting (shielded by an entire ceiling of corrugated plastic) eliminating glare from Saran Wrap which would have tired the eyes. Modern plant innovations were widely apparent as the blueprints came in from engineer after engineer.

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*The Science of . . .*

# Diamond Tool Production

by Richard Bauer, M. E. '59

Few examples better illustrate the transition of an exacting professional skill to a scientifically controlled production process than the development and refinement of industrial diamond tools.

Diamonds have been in use in industry for a long time, but the production and application of diamond tools for the most part has been purely an art. Years go into the development of a technician who knows the intricacies of producing a diamond tool for the processes of grinding, buffing, and cutting that diamonds are called upon to perform.

In the last decade, a decline in this type of extremely skilled technician necessitated the replacement of their indispensable but often fallible skills with a more dependable and abundant scientific knowledge. Among the first companies to feel and recognize this need was the Hamilton Watch Co. In 1941 this company, under the direction of scientific specialists in crystal structure, began the construction of a crystallography laboratory at the Hamilton plant.

The first concern of the new laboratory centered around investigations of the atomic structure of the diamond by X-ray techniques. Using X-ray diffraction, the crystallographic orientation of diamonds could be determined with a degree of accuracy heretofore unknown to human skill. Hence it was no longer necessary to depend on the life-long skill of a technician to determine the planes along which a diamond could be cut easily.

Next it was discovered that the regular arrangement of atoms in the diamond, which is the basis of the diamond's crystal structure, also provided some atom planes which afforded a soft surface, and other planes which afforded a much harder surface. Hence it became standard practice to cut and orient the diamond in a diamond tool so that the cutting face was along the soft diamond surface, to provide a good polishing tool. But for tools to do burnishing or cutting, the diamond was oriented to make its hard atom plane the cutting surface. This resulted in cutting tools which last about ten times as long as tools in which the diamonds are not thus scientifically oriented. Furthermore, tool life is definitely known and not an unpredictable factor as it is with diamond tools in which the diamond is not thus scientifically oriented according to its atom planes.

Further study of the diamond by the crystallography laboratory showed that the cutting edge on a diamond tool is amazingly smooth compared to the cutting edges of metal or carbide tools. Hence it is possible, by machining metals with diamond tools, to produce a surface even smoother than a "mirror finish." With this as guide, Hamilton set up its production procedures so that many parts which require a high luster finish are not plated, then polished and buffed, as is the common practice today. Instead they make high-luster parts of stainless steel type alloys and finish-machine the parts with diamond tools, thus producing a smoother finish than even the mirror-finish achieved by the finest polishing and buffing.

After extensive work in determining the proper orientation of the diamond in the tool, the laboratory proceeded to

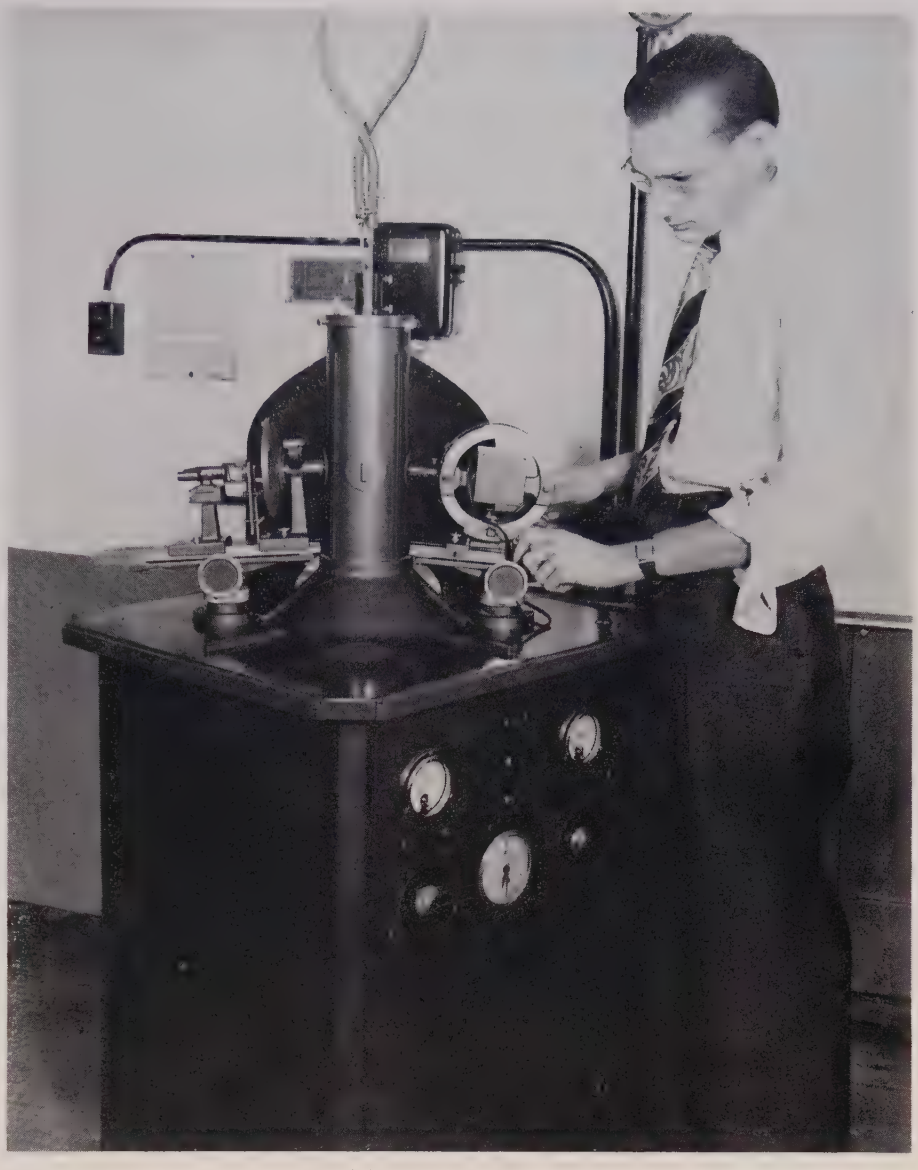
Operator checks correct orientation (angles) of tool cutting faces with optical-measuring instrument (goniometer).

explore better arrangements for mounting diamonds in the tool. For example, diamond laps are made by pressing diamond grains into a soft copper rod or disc. This would result in a weak bond of the diamond to the metal, and the diamond chips would rapidly drop out. The problem was solved by the development of a bonding process in which diamond chips are mixed with powdered metal and the whole mass is then sintered. The diamond chips are thereby fused into the metal, and are bonded securely to the tool.

This intering-bonded technique proved useful to Hamilton's watch production process, because their procedure for mass production of small flat parts (main and partial watch and instrument base plates) is based mainly on producing accurate contours and holes by punching the flat parts in high precision carbide dies. These dies can be easily machined to the desired fine finish and accuracy with diamond tools, particularly the diamond laps, formed by this sintered-metal bonding process.

The crystallography laboratory also examines the diamond powders under X-ray and microscope to insure uniformity in particle size. This is important because coarse grains can be used in tools for rough cuts, but laps for finishing require a very fine diamond particle size. Furthermore, the body of the sinter-bonded diamond lap is made oversize and is ground down to accurate size with an alundum wheel. This insures a lap of precise size to produce holes of accurate dimensions.

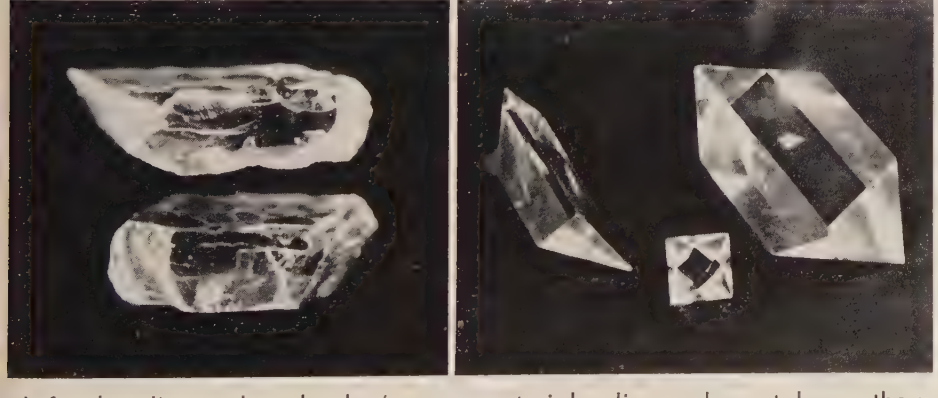
From the research to create new advances in diamond tools the crystallography laboratory went on to improve diamond tool production. As a result, it now produces all the diamond tools required by Hamilton and a good deal more for other manufacturers. These diamond tools included a diamond saw, which cuts carbides and operates at a speed of 5,000 rpm., diamond laps and wheels, carbide gage points, diamond dies for wire drawing, and diamond polishing and cutting tools.



Operator setting up X-ray diffraction unit for determination of diamond's atom planes. (All photos by Hamilton Watch Co.)

A unique by-product of diamond die production has been the development of a special design of flat die that permits drawing metal strip into extra fine, perfectly flat fine wire for watch hair springs. The conventional process for producing such wire comprises drawing down a round wire to the approximate size desired, then rolling it flat. This does not produce a wire of as uniform thickness, or with the exceptional flatness, and smooth edges as is achieved by the flat-drawing process.

Summarizing, engineered diamond tools are now available to the metal working industry which have a long life, and which have the right characteristics for the desired metal working job. The way has thus been paved for the metal working industries to achieve new advances in: 1) Machining the extra-hard new tool and die materials (carbides and cermets); 2) extremely close tolerance machining of small parts; and 3) the use of diamond tool machining in place of polishing or buffing to produce ultra-smooth finished surfaces.



Left, the diamond toolmaker's raw material—diamond crystals as they appear "in the rough," when received by the toolmaker. At right, models of diamond crystal structure. Prismatic crystal structure is due to arrangement of diamond atoms in regular layers of atom planes.

*World's most powerful production aircraft engine*

The J-57 axial-flow jet engine with afterburner, designed and developed by Pratt & Whitney Aircraft.

*The University . . .*

# Rocket Society

by Maurice H. Garnholz, Aero E. '56

In August of this past year, the United States definitely announced its plans to attempt to establish a space station above the periphery of the earth's atmosphere by means of a step-rocket launching. Here on the campus for two years has been a student organization interested and engaged in learning more about how activities such as this can be accomplished and specifically about the driving force mechanisms—rockets.

During the school year of 1953-54 and under the able faculty direction of Dr. T. P. Torda, a group of engineering students interested in rocketry founded the Illinois Rocket Society. The purpose of the club was and is to learn more about rocketry and its related fields by experimental and analytical research, and to disclose this knowledge to the membership body.

The Illinois Rocket Society was and is different from so many seemingly-similar campus engineering groups in the fact that it was to meet once a week, and also its members intended to design and build an actual working rocket engine. A possible auxiliary outcome of this project was to be the founding of a rocket research division within the aeronautical engineering department of the University, such as is found at Purdue University. In fact, an excursion to observe Purdue's test facilities in this area was sponsored by the IRS during the first year of its existence.

The proposed rocket engine—not an entire missle capable of flight—was and is to be used for experimental research to acquaint the members with testing procedures of a rocket engine and also to provide a first-hand knowledge in this as yet "gremlin-infested" field of engineering endeavor. Essentially a dynamometer-type of test is to be run, such as is done with automobile reciprocating engines.

Students from many phases of engineering have joined the IRS, thus adding a diversity of specific talents and knowledge to the organization—aeronautical, ceramic, chemical, mechanical, physics, electrical.

The design of the rocket engine entailed a review of nearly all of the courses taken by the members while in college. Physics, thermodynamics, metallurgy, mechanics of materials, knowledge of machine-shop and foundry methods, calculus, and others all played a major part in designing the rocket engine. Moments of inertia, critical throat areas, ultimate strengths of materials, coefficients of heat flow, and resonating frequencies of the combustion chamber all became important and had to be accounted for.

Besides the final desired goal—the completion and actual operation of the rocket engine on the test stand—other things have become apparent to the members. One of the most important is the fact that good coordination of any engineering project is a must. Although all participants of the project may be capable of doing nearly any assigned task, unless they are told exactly what to do and when it is to be due, progress is slow and often non-existent. Therefore, in designing the rocket engine, the IRS made several cursory divisions of work so as to both speed the job and to prevent duplication of effort. These were as follows: preliminary thermodynamic design, test stand, instrumentation, and mechanical design. This also allowed each person to engage in the particular area where he was best suited and also of his major interest.

In the division of preliminary thermodynamics, the matrix of the whole project, "starting from scratch" is a gross understatement. Calculations were run on the different pressures, temperatures, flame velocities, stoichiometric combustion, fuel-oxidizer ratios, length of combustion chamber, etc. that would be necessary—all after several logical assumptions. At this stage aid was needed and obtained from Dr. Torda, and also from George P. Sutton's book, *Rocket Propulsion Elements,* and Maurice Zucrow's text, *Jet Propulsion and Gas Turbines.*

During the previous summer, Dr. Torda had been employed by Aerojet-General Corporation in Azusa, California—the nation's second largest producer of rocket engines—and thus furthered his already large knowledge of rockets. Much of this information was divulged to the society in forms of talks and in advice on the society's design.

The group concerned with the test stand was to figure out how to mount the engine so as to hold it on the stand securely and also to be able to take thrust readings. Vibration played a large role here.

Methods of measuring combustion chamber temperatures, pressures at two or three locations in the rocket, and thrust were the main considerations in this category. The first two provided much consternation, since the temperature one or two seconds after starting was calculated to be in the neighborhood of 4000 degrees F.—well above the melting point of steel and thermocouples.

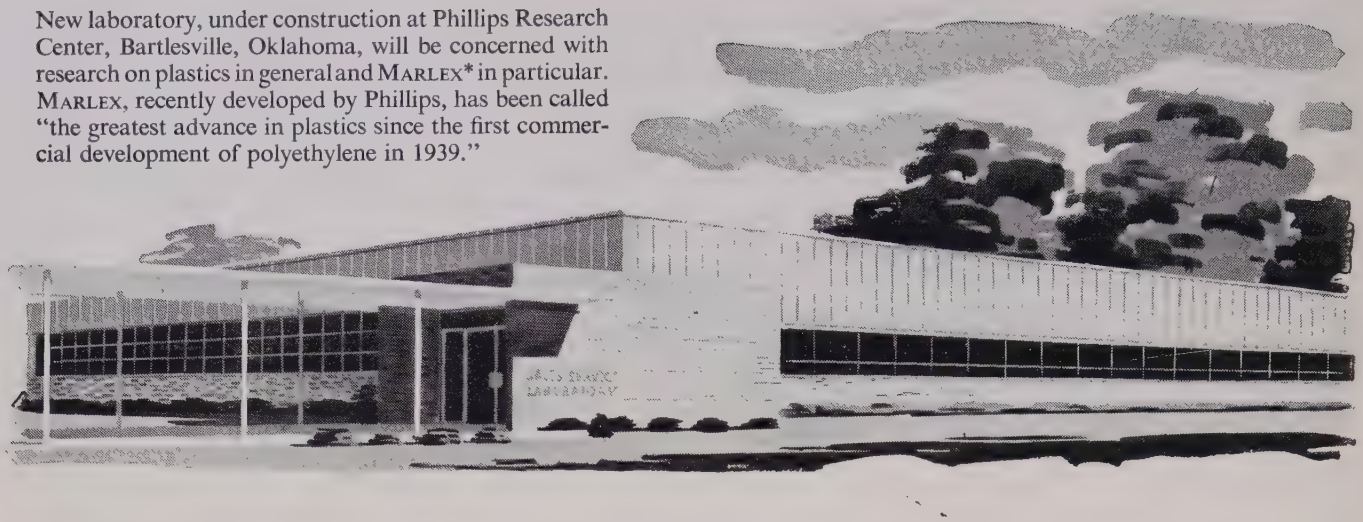
The mechanical design group had to pick the best possible material with regard to stresses and temperature, decide on fasteners, possible cooling, positions of fuel and oxidizer lines, type of injector, external features, etc.

Although Dr. Torda is no longer here at the University, the final design was finished this semester under the auspices of Professor R. W. McCloy also of the aeronautical engineering department. The rocket engine is to utilize ethylene ($C_2H_4$) and compressed oxygen as fuel and oxidizer combination. (The preliminary choice was propane ($C_3H_8$) and oxygen.) The combustion chamber was to have a 3-inch inside diameter and be about 8 inches long. During combustion the temperature was computed to be about 5000 degrees F. About 300 pounds thrust would be generated. But due to the enormous cost and shop labor time that would be necessitated by this rocket project, and due to its extremely short operational life-time—a few seconds—it was decided by the society to build a gasoline and air rocket engine with water cooling. This will be much easier to design and operate than the more complicated ethlyene and oxygen powered rocket. The present proposed engine will probably be designed and built by February.

Possibly the IRS will, in the near future, become a student branch of the American Rocket Society—the nation's largest organization of engineers, scientists, and experimenters devoted to the fields of rocketry, jet propulsion, and astronautics.

As we remain in the guided missle era and approach nearer and nearer the epoch of space satellites and interplanetary travel—with the rocket engine at present providing the best means of propulsion to reach beyond the fringes of the earth's atmosphere—the Illinois Rocket Society's efforts seem increasingly justified and less like the antics of "space-ranger" proteges.

New laboratory, under construction at Phillips Research Center, Bartlesville, Oklahoma, will be concerned with research on plastics in general and MARLEX* in particular. MARLEX, recently developed by Phillips, has been called "the greatest advance in plastics since the first commercial development of polyethylene in 1939."



# Opportunities in Petrochemistry

Petroleum hydrocarbons are playing an increasingly important role in our national economy, providing the raw materials for the manufacture of plastics, chemical fertilizers, carbon black, rubber and various intermediate products. Phillips Petroleum Company, by virtue of its huge reserves of raw materials and its long-continuing program of research, has achieved a position of leadership in the petrochemical field. To the technical graduate Phillips is able to offer exceptionally interesting opportunities in scientific research, or in its practical applications in the business world. For further information write to our Employee Relations Department.

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**PHILLIPS PETROLEUM COMPANY,** Bartlesville, Oklahoma

*Previewing . . .*

# CONQUEST OF SPACE

by David S. Cox, E. E. '59

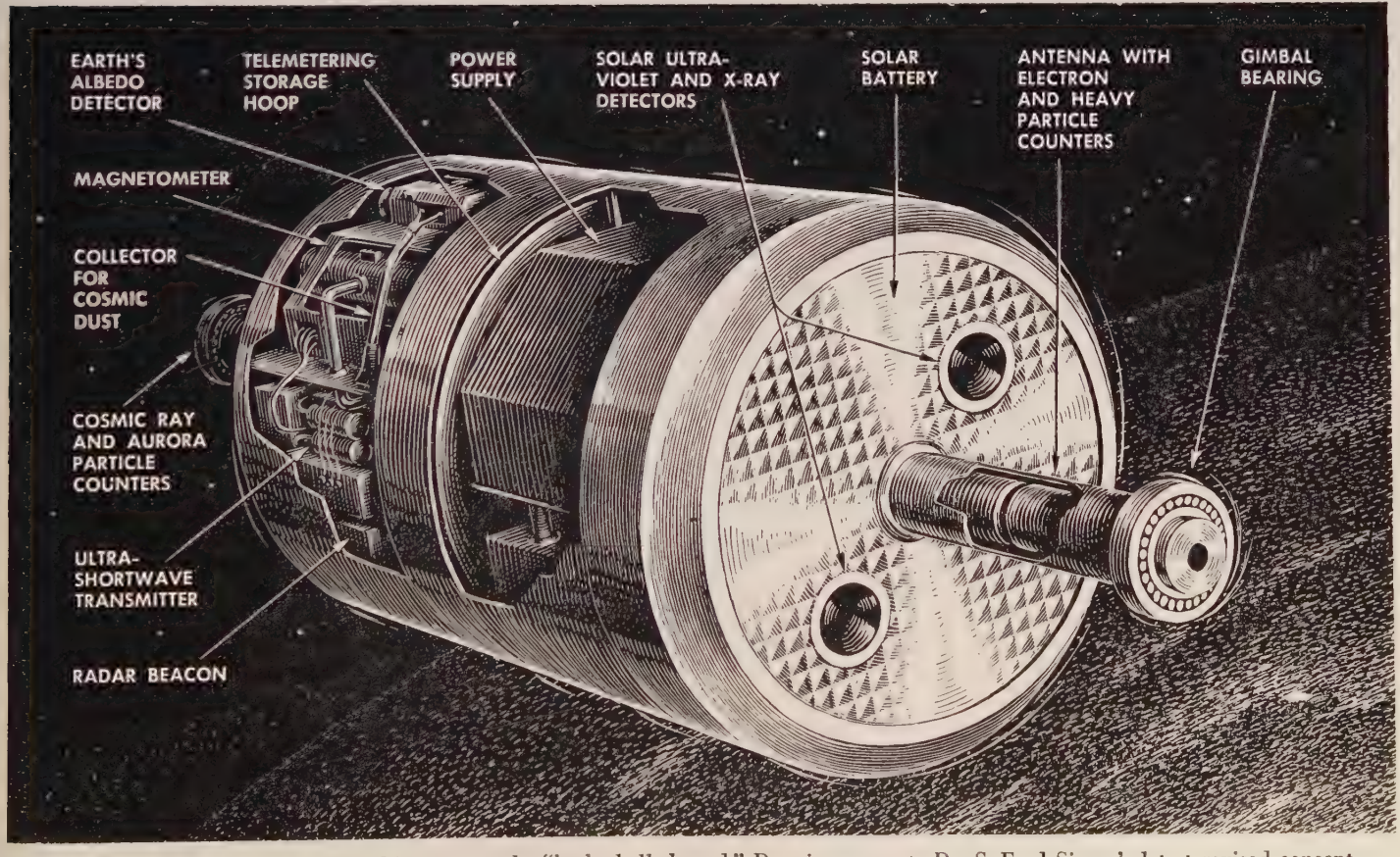
At the White House July 29, Detlev W. Bronk, president of the National Academy of Sciences, and Alan T. Waterman, director of the National Science Foundation announced the plans for the construction of a small earth-circling satellite vehicle. Scientists expect to complete the satellite developmnetal work in time for a successful launching of one or more vehicles during the International Geophysical year, a period selected during 1957 and 1958 for world-wide observations in the fields of the earth sciences by some 40 nations. The participation of other nations engaged in the IGY program is invited, and to this end we shall provide full scientific information on the orbiting vehicle so that other nations may monitor the device and make appropriate observations.

The list of nations that will participate in the IGY program includes: Argentina, Australia, Austria, Belgium, Brazil, Burma, Canada, Chile, Czechoslovakia, Denmark, Finland, France, East Germany, Great Britain, Greece, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Mexico, Morocco, Netherlands, New Zealand, Norway, Pakistan, Peru, Philippines, Spain, Sweden, Switzerland, Thailand, Tunisia, Union of South Africa, U. S. S. R., United States, and Yugoslavia. Each country will plan and execute its own program, under a general plan developed and coordinated by the Special Committee for the IGY.

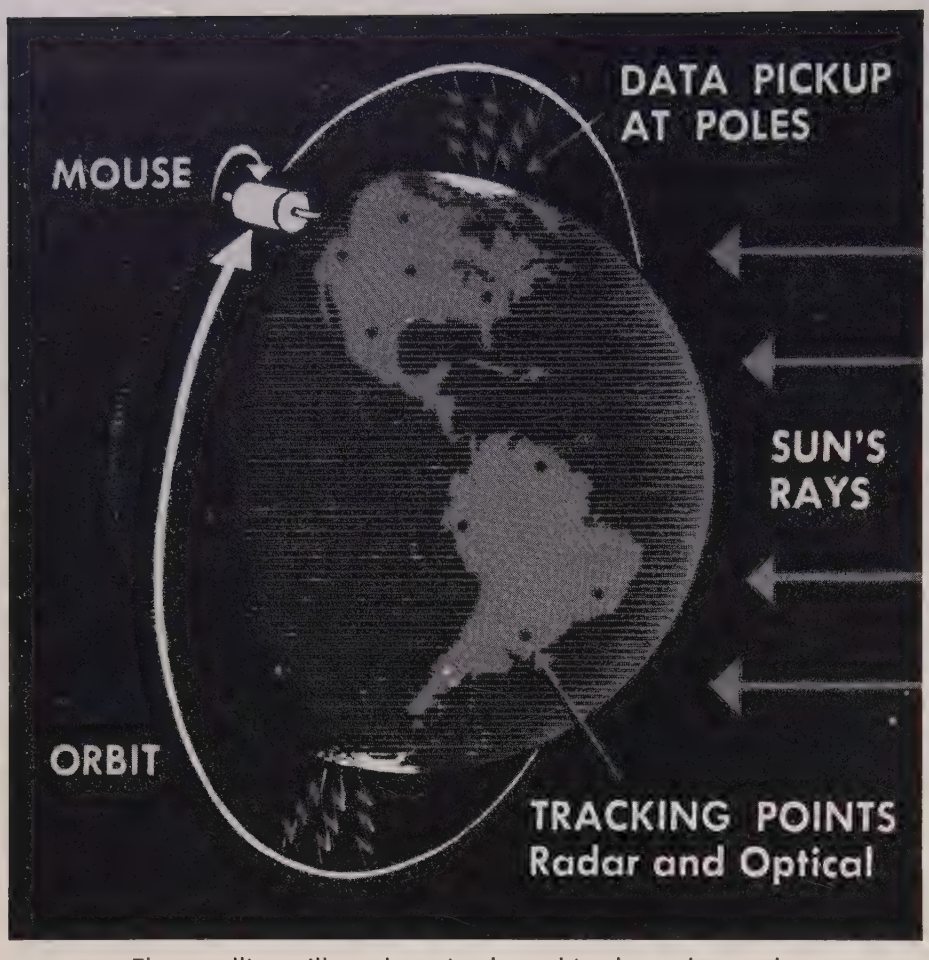
The relatively modest scope of the official project announced by the United States, many scientists agree, is easily attainable by launching a three- or four-stage rocket requiring very little improvement over present types. This would carry aloft and release a simple instrument package or satellite, at an altitude of 200 miles, to orbit once around the earth every 90 minutes, for from one to 20 days.

Research and development in the last 15 years has proceeded at an ever-accelerating pace. Since 1940, three notable activities—atomic energy, electronics, and propulsion—have been racing forward, side by side. Atomic energy gives low-cost materials and structures. Electronics research has provided improved channels of communication, leading to automatic stabilization and control equipment as well as electronic brains for solution of complex research problems. Propulsion research has given engines for new modes of transportation, leading to rocket engines for high-speed flight.

The growth and development in the




**Initial satellite vehicle for low orbits may not be "basketball shaped." Drawing suggests Dr. S. Fred Singer's latest revised concept.**




The satellite will track a circular orbit about the earth.

astronautical sciences has been noteworthy. In 1944, the first operational V-2 rocket was launched. Now—only 11 years later—the first satellite project has been initiated. This exceeds even the rapid pace of developments in the aeronautical and electronics sciences during the last 50 years. The V-2 though capable of attaining a speed of about 3,500 mph, is extremely slow in comparison with the 17,000 mph required for orbital rockets.

A WAC Corporal (a rocket) shot from the nose of a V-2 rocket over White Sands, N. M., Feb. 24, 1949, rose to a height of 250 miles, about the height at which the earth's first artificial moon will circle. She stayed there just a short time, however. Numerous rocket flights to lower altitudes since then have resulted in improved techniques for radioing back to earth information on conditions high in the atmosphere.

The first public impression was that America's experimental vehicle would be a spherical object like a basketball. As this project advances, however, our first primitive satellite may not be spherical at all, but a cylindrical, rotor-like spinning shape released from carrier gimbals in the final rocket stage. Thus, for needed stability on its orbit, the entire vehicle will spin as a gyro and hold a fixed attitude in space for continuous solar measurements, cosmic-ray, and other studies.

One of the best documented, and most detailed proposals for a practical satellite—at an orbit within present rocket capabalities—is Dr. S. Fred Singer's M.O.U.S.E. (Minimum Orbital Unmanned Satellite Earth). This conception very closely represents the needed instrument in size, weight, usefulness, cost, and time schedule. Doctor Singer's latest studies at the University of Maryland have already evolved beyond simple spheres to the gyro drum shape suggested by the picture accompanying this article.

The Mouse, though physically small, is actually a complex package of delicate instruments. In its simpler form, the Mouse, a miniature physics laboratory, cylindrical in shape, weighing only 44 pounds, with a cross-sectional area of about one square foot, may be equipped for the detection of as many as 8 to 10 characteristics of the upper atmosphere. Although proposed two years ago, it now takes on new importance.

Within its weight limits sufficient miniaturized equipment is installed for the needed research studies. A silicon wafer solar battery provides electrical power for its instruments, radar marker beacon, and telemetering system. The solar battery and detection equipment, however, require orientation of the satellite with reference to the sun. This will be achieved by the spin stabilization (gyro effect) of the entire vehicle about the antenna axis. The satellite, acting as a gyro, will thus maintain proper orientation continuously as it orbits around the earth. It will be set spinning on the ground on gimbal bearings with the gyro reference axis established prior to launching.

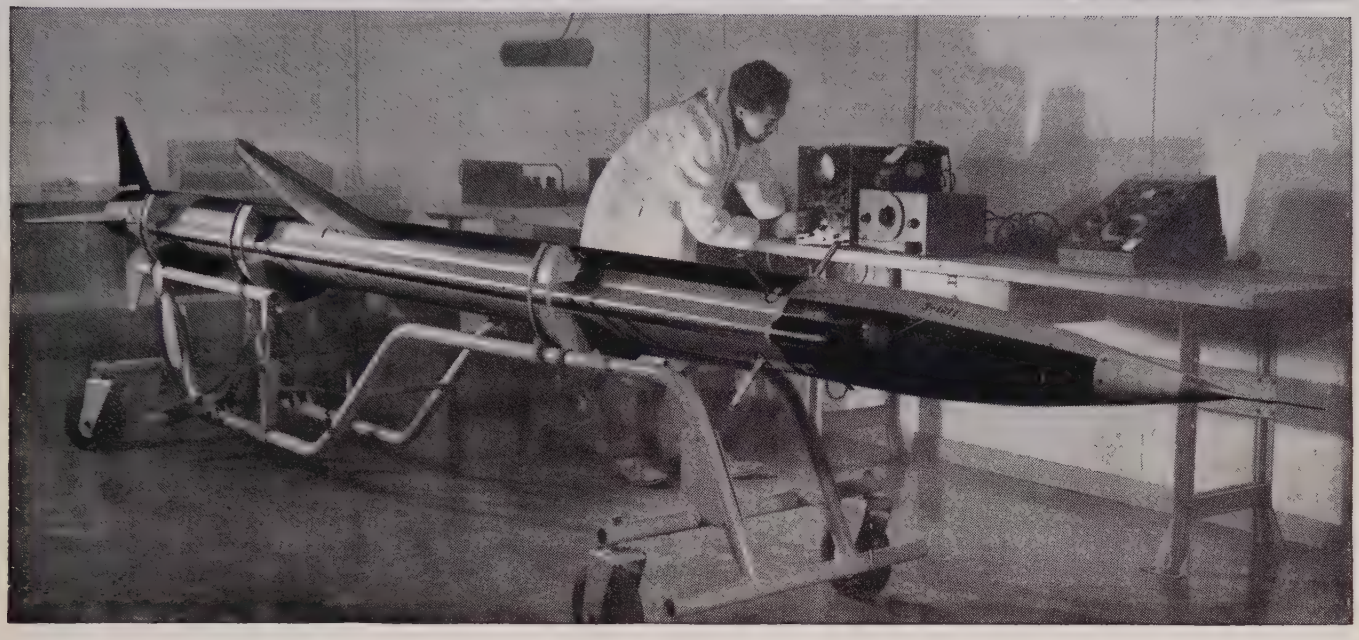
It will orbit around the earth for a period of days at a height of 200 to 300 miles, gradually circling back into the upper atmosphere where it will eventually disintegrate harmlessly. Painted white for tracking, the satellite will reflect sun's rays in the same manner the moon does. Best time to see it will be twilight.

Little attention has been given thus far to the means of propulsion, or boost stages, to place the satellite on its orbit. The multistage carrier to do this may have three or four chemically fueled rocket stages with independent staging used; that is, each propulsion stage would be a separate system. A more efficient system, however, may use dependent staging wherein all rocket engines operate in unison until jettisoned. The propellants may be conventional chemicals whose specific thrust does not differ appreciably from the standard propellant combinations, such as liquid oxygen and alcohol or hydrazine and nitric acid.

The $10 million appropriated for an actual Earth Satellite Vehicle (ESV) program should give returns on dollar investment without precedent. At costs on the order of Doctor Singer's estimate of $1.5 million per Mouse, the new appropriation could provide about six instrumented vehicles—but perhaps only four of these need be low-orbit satellites as originally planned, so that two others could be special rockets probing space as far as the moon or beyond! Once established in its orbit, the satellite will be able to telemeter information to earth about conditions in the outer edge of the atmosphere. It can also report on extra-terrestrial radiations and particles that are shielded by the earth's atmosphere—ultraviolet radiation cosmic rays, meteors, and so forth —that have a strong influence on the upper atmosphere and indirectly affect the lower atmosphere.

A few of the principal uses for larger satellites, manned or unmanned, aside from the direct research studies considered for the minimum satellite are (1) earth-surface reconnaissance, (2) communication relay stations, (3) weather prediction, (4) astronomical observation, and (5) as a departure point for deep space.

Dr. J. R. Pierce of Bell Laboratories has suggested the possible use of low-



## Boeing engineers are insiders on top-secret work

Engineers are doing vital work on significant new developments at Boeing. For example, the Boeing BOMARC IM-99 pilotless interceptor. Its predecessor, the Boeing GAPA, is shown here, because photographs of BOMARC are highly classified. BOMARC is a supersonic long-range missile that spearheads an entirely new weapons system. It is a key weapon in America's defense planning.

BOMARC, as well as other "years ahead" Boeing projects, which cannot be discussed here, are complex challenges to all kinds of engineers. These men find real creative interest in the problems of very high speed flight: heat, compressibility, vibration, rocket, jet and nuclear power, miniaturization, electronic control, and others. Their goal is to design structures and components that will "weigh nothing and take no space," yet withstand extreme velocities and altitudes.

The prestige of Boeing engineers is second to none. They have created such recent aviation milestones as the B-52 global jet bomber, the 707 jet transport, and the B-47. There are superb facilities at Boeing: the multi-million-dollar new Flight Test Center, the world's most versatile privately-owned wind tunnel, the latest electronic computers, and much more.

Boeing engineers enjoy exceptional opportunities for career stability and growth. There are more than twice as many engineers with the firm now as at the peak of World War II. Living is pleasant in the progressive, comfortable-size communities of Seattle and Wichita.

There is room for top engineering talent on Boeing research, design and production teams. If you feel that you belong with aviation's leader, it will pay you to investigate the advantages of a career with Boeing.

For further Boeing career information, consult your Placement Office or write to either:

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density satellites, that is, metal-foil spheres of diameters up to 1,000 feet. For the use of remote reflectors in trans-oceanic communications, 3 such spheres, placed on 24 hour orbits, could provide a communication system (television, radio, and telephone) to 90 per cent of the earth's surface.

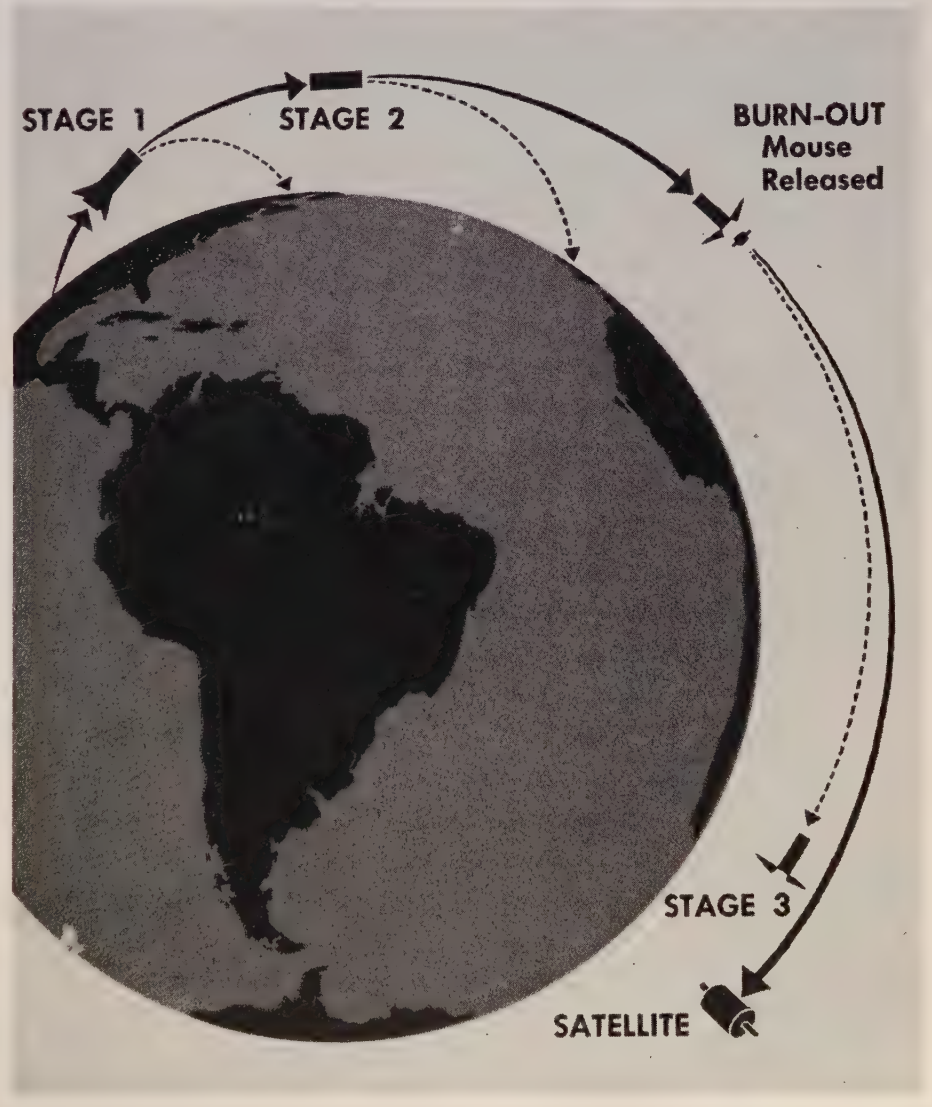
The first satellite will not be manned even by a mouse; however, it will be followed by others. If the information gained from the first and later circling satellites show that man could probably survive in outer space, humans will follow the test animals as inhabitants of space satellites. Then later, they may man space ships that will reach first for the moon, next for the planets. This is for the future but just how far in the future is hard to tell.

The principal problem is not propulsion, but that of guidance and control. The special trajectory required for successful return from a trip around the moon demands more precise control than does the relatively low ascent to close-orbits near the earth.

Truth is, present advancement of the rocket art is capable today of producing the required escape speed of 25,000 mph, if the final stage is fired from orbit speeds of 17-18,000 mph.

Research activity directed toward new high-energy propulsion systems including chemically—as well as nuclear-powered rocket engines for ascent from the earth's surface to a satellite orbit, and nuclear-powered or solar-powered ion-electron beam rockets for micro-gravity accelerations to be used on interplanetary transits will give impetus to the conquest of space.

Improved materials and structures; increased reliability of components; automatic control equipment; research activity in the field of electronic computers that handle specialized information; studies of the upper atmosphere, extra-terrestrial physics, and physics of the solar system; research in space medicine; the use of algae for food and atmosphere control in long interplanetary transits; considerations for the unified-field theory in physics and anti-gravity studies, will further accelerate the development of full-fledged space travel.




In this diagram, the three stages of the earth-circling satellite are shown.

# Techno-Cutie *for* January

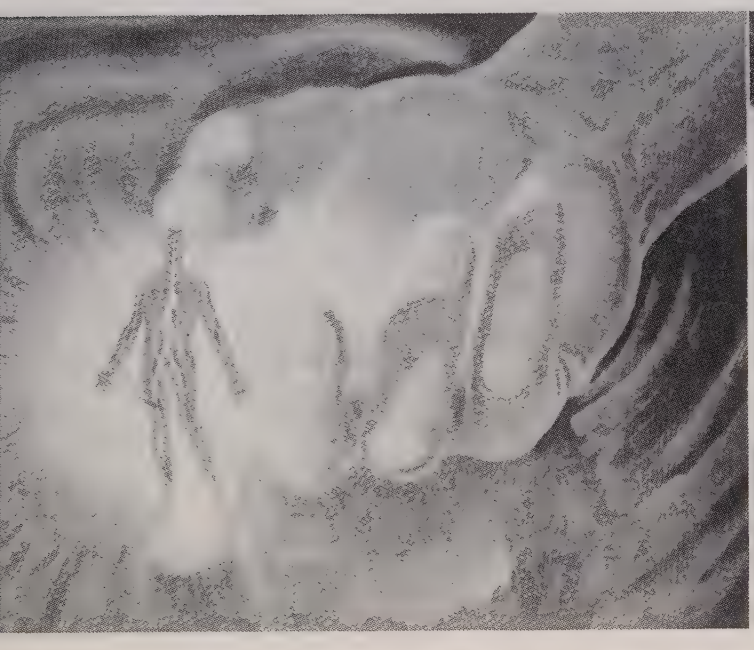
☆

Our Technocutie for January is Miss Judy Kelch, a resident of LAR on campus. Judy, who hails from Chicago, is a sophomore in FAA, majoring in painting. She is a member of the University Chorus and she reigned as Miss Indiana in the Homecoming Queen's court. In her spare time, when she has any, Judy enjoys painting, tennis, ice skating, and playing the piano. Judy is 18 years old, stands 5' 2", and weighs 112 pounds. She has red hair, brown eyes, and her vital statistics are something like 35-24-35. If anybody is interested, she hasn't made any permanent contacts, and the field is wide open.

(Staff photo)

# A job you can

*Union Carbide offers you opportunities to grow in some of the most rapidly expanding fields in industry. You may have the qualifications that will help you to "get in on the ground floor" on new developments by the*



RADIOISOTOPES — Union Carbide's Divisions are leaders in the field of nuclear research and development. One Division, Union Carbide Nuclear Company, operates for the government Oak Ridge National Laboratory, the Nation's chief source of radioisotopes. In medicine, radioisotopes are used to investigate the human bloodstream —how it supplies nourishment, defends against disease, or becomes diseased itself.

TITANIUM — Electro Metallurgical Company is rapidly completing a new plant to produce titanium, the wonder metal whose strength and lightness are combined with resistance to heat and corrosion. The new plant will use a process developed by Union Carbide research, and will have an annual capacity of 7,500 tons of crystalline sponge —half again as much as the total United States production in 1954.

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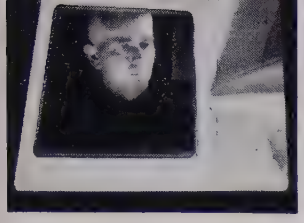

**Carl Vrooman,** icing tunnel group head, studies hot-air cyclic de-icing test on wing section of C-130 transport. The tunnel has a temperature range of —40° F. to +150° F. and maximum air speed of more than 270 mph.

# Icing tunnel speeds thermodynamics research at Lockheed

Designed to meet a constantly increasing volume of thermodynamics work, Lockheed's icing research tunnel provides year 'round testing in meteorological environments normally found only in flight. It is the first icing research tunnel in private industry.

Lockheed thermodynamics scientists were formerly limited to testing time available at installations such as Mt. Washington. Now they are able to study in greater detail problems such as: thermal anti-icing; cyclic de-icing; various methods of ice removal; distribution of ice; rate of temperature changes in aircraft components; thermodynamic correlation between laboratory and flight testing; and development and calibration of special instrumentation.

**B. L. Messinger,** department head, analyzes test results with Thermodynamics Engineer E. F. Versaw and Thermodynamicist Tom Sedgwick. The report was in their hands *only two days* after it was decided to conduct the test.

**C. H. Fish,** design engineer assigned to the tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has refrigeration capacity of 100 tons, provides icing conditions of 0 to 4 grams per cubic meter, droplet sizes from 5 to 1000 microns.

# Thermodynamics career opportunities

Increasing development work on nuclear energy, turbo-compound, turbo-prop and jet transports, radar search planes and supersonic aircraft has created a number of positions for Thermodynamics Engineers and Thermodynamicists.

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Her tail on the ground, her nose in the air, the flaming giant zeppelin, Hindenburg, crashes to earth, a mass of ruins after an explosion rent her in mid-air at Lakehurst, N. J., May 6, 1937. (AP photo)

*The Story Behind . . .*

# Lighter Than Air

by Jim Piechocki, Aero E. '56

***The development of these great airships was one of the engineering marvels of the age***

Now what could be a more dull and uninteresting subject than that of the dirigible? Are there any among us who have ever charmed an audience with a discussion of balloons, and has the topic of lighter-than-air craft ever smashed the best-seller barrier? The high octane, air-minded youth of today seldom render an admiring glance at a passing blimp, as it seems to be a vehicle which stimulates nothing more than idle curiosity and hushed awe, leaving these somewhat obese aircraft in a sad state. But don't tell this to the United States Navy.

The truth of the matter is that the history of lighter-than-air craft is interesting, informative, and at times amusing. Furthermore, the aeronautical development devoted to airships gave this country a formidable defensive weapon in World War II. Yes, supersonic airplanes will come and go, and the dirigible will always find itself chugging along behind the pack. But a dirigible is a dirigible and of this, mind you, the United States Navy is fully aware.

Before we continue, we must educate ourselves in lighter-than-air nomenclature (if you'll pardon the expression). The term airship is applied to aircraft which depend upon buoyancy forces for creating lift. That is to say, a dirigible or balloon, flies in the air for the same reason a cork floats on water. This is all well and proper because Archimedes said it was. Archimedes was a pompous old Greek who thought strenuously about such things. Historians tell us that Archimedes flourished somewhere between 80 and 50 B.C. (Some engineers are still wondering just what it was that he flourished.) Well anyway, Archimedes stated in so many words the proposition that if an object is placed in a fluid and it displaces a volume of that fluid whose weight is greater than that of the object, that object will float. In the case of the airship or the balloon, the fluid is air and flight is accomplished by reducing the specific volume of the ship to such a low value that it will displace a weight of air greater than its own. Ingeniously enough, early dirigible minds and balloon heads (once again, pardon) decided that the reduction of the specific volume of their airships could be accomplished by filling them with a gas which was lighter than air. Hydrogen and helium served the purpose nicely. Many early experimenters, obviously unacquainted with Archimedes, built bonfires and filled their balloons with the escaping gases, thinking that the smoke was doing the trick. In actuality they were on pretty good terms with Archimedes after all, because the heated air they captured was less dense than the surrounding atmosphere. So there it was—buoyancy. *Voila!*

At sea level air weighs about 81 pounds per thousand cubic feet. Hydrogen, helium, and coal gas, because they are lighter than air, are capable of creating lift. Hydrogen weighs about five pounds per thousand cubic feet, and helium about eleven. Their corresponding lifts are the difference between the specific weights of the air and the gas. This means that a thousand pounds of hydrogen can lift 76 pounds of dead weight. Similarly, the specific lift of helium is 70 pounds. Impurities in the air reduce the effective lifts of hydrogen and helium to around 68 and 62 pounds, respectively. Coal gas finds no popular usage in large airships because of its relatively great weight.

Hydrogen costs approximately six dollars per 1,000 cubic feet, while helium is much more expensive at fifteen dollars for the same volume. The lesser lift of helium is offset by its noninflammable properties, the gas being inert. Shipment and storage of helium is exceedingly complicated.

Airships have been divided into three classifications, non-rigid, semi-rigid, and rigid. The non-rigid or blimp type, consists of a gas-tight fabric envelope which maintains its form by the pressure of the lifting gas and additional air balonets (which inflate and deflate to compensate for changes in pressure differential) contained therein. The semi-rigid airship similarly depends upon the internal pressure of the gas to sustain its form but has in addition, a supporting metal keel extending along the longitudinal axis. Both of the aforementioned types are called pressure ships because they depend on a pressure differential across the envelope to maintain form. This feature distinguishes them from the rigids, which rely on a structural frame to maintain form irrespective of internal gas pressure. The entire structure is fabric-covered and inside are contained large gas cells filling the length of the ship.

An airship is termed "light" when the weight of the entire craft is less than the lifting forces of the gas. A "heavy" airship is one whose weight is greater than the total bouyant force. This does not make the heavy airship impossible to fly, as aerodynamic lift can be obtained by flying at a slight positive inclination to the free stream

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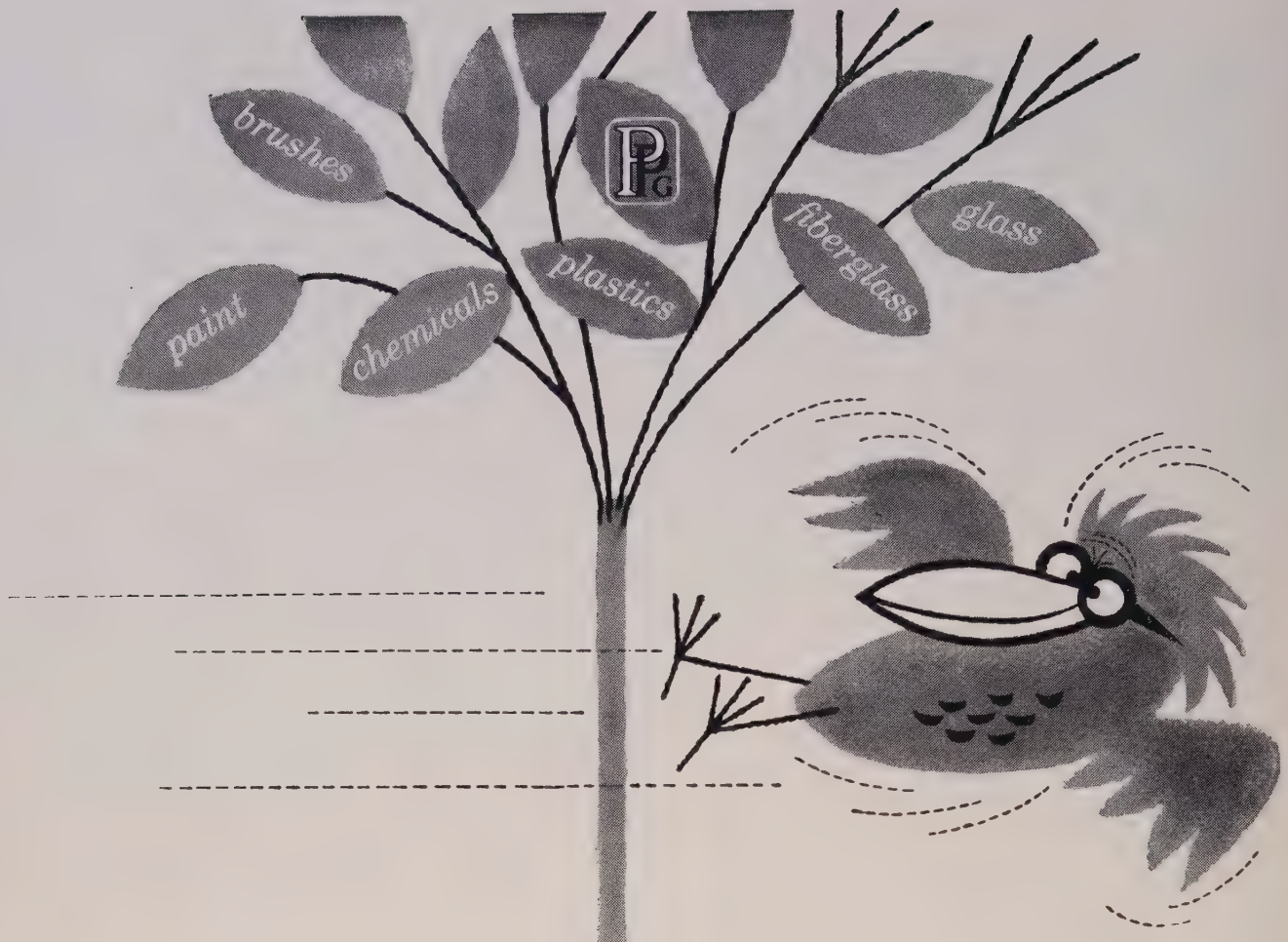


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## *Lighter Than Air . . .*

(*Continued from Page* 37)

air. The cigar-shape of the dirigible is not the most aerodynamically efficient airfoil, but its great size enables it to generate enough dynamic lift to offset any reasonable amount of heaviness. Some Navy airships are as much as 6,000 pounds "heavy," and require a short take-off run before becoming safely airborne. "Light" airships require no take-off run, and generally fly at slight negative inclination (angle of attack).

The earliest lighter-than-air craft were, of course, balloons. The famous Montgolfier brothers of France in 1783, performed a successful experiment at Versailles whereby they sent aloft a linen globe 105 feet in circumference filled with the gases collected from a fire of chopped straw. The news of the experiment attracted wide-spread attention, and the Montgolfier brothers were asked to repeat their experiment, which they did, this time in the presence of the king and queen and a great crowd of sepctators. On the second attempt, a cage was suspended below the balloon in which were placed a sheep, a cock, and a duck. They landed without mishap, except the cock, whose right wing was injured by a kick from the sheep. The first person to go aloft in a balloon was Jean Francois Pilatire de Rozier, who made the ascent Oct. 15, 1783. Only 10 days later, J.A.C. Charles ascended from Paris in a hydrogen-filled balloon. The balloon stayed aloft two hours and landed 27 miles from the point of ascent. In Great Britain, Vincent Lunardi and Count Francesco Zambecarri were performing numerous experiments of a similar nature. The first balloon crossing of the English Channel was made by Jean Pierre Blanchard and Dr. J. Jefferies, an American physician. Balloons saw limited use in the French Revolution and later, the Civil War, but their effects were more often humorous than strategic. In the early 1800s, the French found balloons quite useful for scientific study of the upper atmosphere, but interest began to wane as man searched for a good method of control and propulsion—neither of which was afforded by the unwieldy balloon. Enter the dirigible.

In 1851, Henri Giffard, who had invented a steam injector, developed a 350 pound steam engine or three horsepower capable of turning an 11-foot propeller at 1,100 rpm. A year later, he built an 88,000 cubic foot airship upon which he mounted his engine. On Sept. 24, 1852, rising from the Hippodrome in Paris, and cruising in a light wind at six miles per hour, Giffard demonstrated the first control ever exerted on a lighter-than-air craft.

Paul Hoenlein, a German engineer, made the first application of the internal combustion engine to airship flight when in 1872 he designed and built a dirigible propelled by an engine drawing its fuel from the envelope. In 1883, the Tissandier brothers, Albert and Gaston, built and flew an airship powered with a 1.5 horsepower electric motor. It was considered an accomplishment of world-shaking importance when "La France," an airship powered with an eight horsepower electric motor, flew with sufficient stability enabling it to land at the point of ascent. The Germans joined the dirigible craze and brought along some startlingly new ideas around 1897. With the 130,000 cubic foot "David Schwarz," which consisted of an aluminum framework covered with aluminum sheeting they presented the first airship ever to utilize a gasoline engine, and although a series of malfunctions caused failure of the initial flight, the true potentiality of the rigid airship was at last revealed.

Of extreme importance was the construction in 1900 of the first Zeppelin airship, the LZ-1. It was the brainchild of Count Ferdinand von Zeppelin, a German Army officer who retired to devote full attention to the development of a radically different kind of airship. The "Zeps" were huge—larger than anything previously conceived. The LZ-1 was 420 feet long, 38 feet in diameter and had a useful gas volume of 388,410 cubic feet.

With the construction of the Zeppelins, and the emergence of Germany in 1914 as a world power, the dirigible took on the costume of a strategic weapon of war. Germany's rigids, developed to a point of great strength, large load-carrying ability and good performance, were put to extensive use by the

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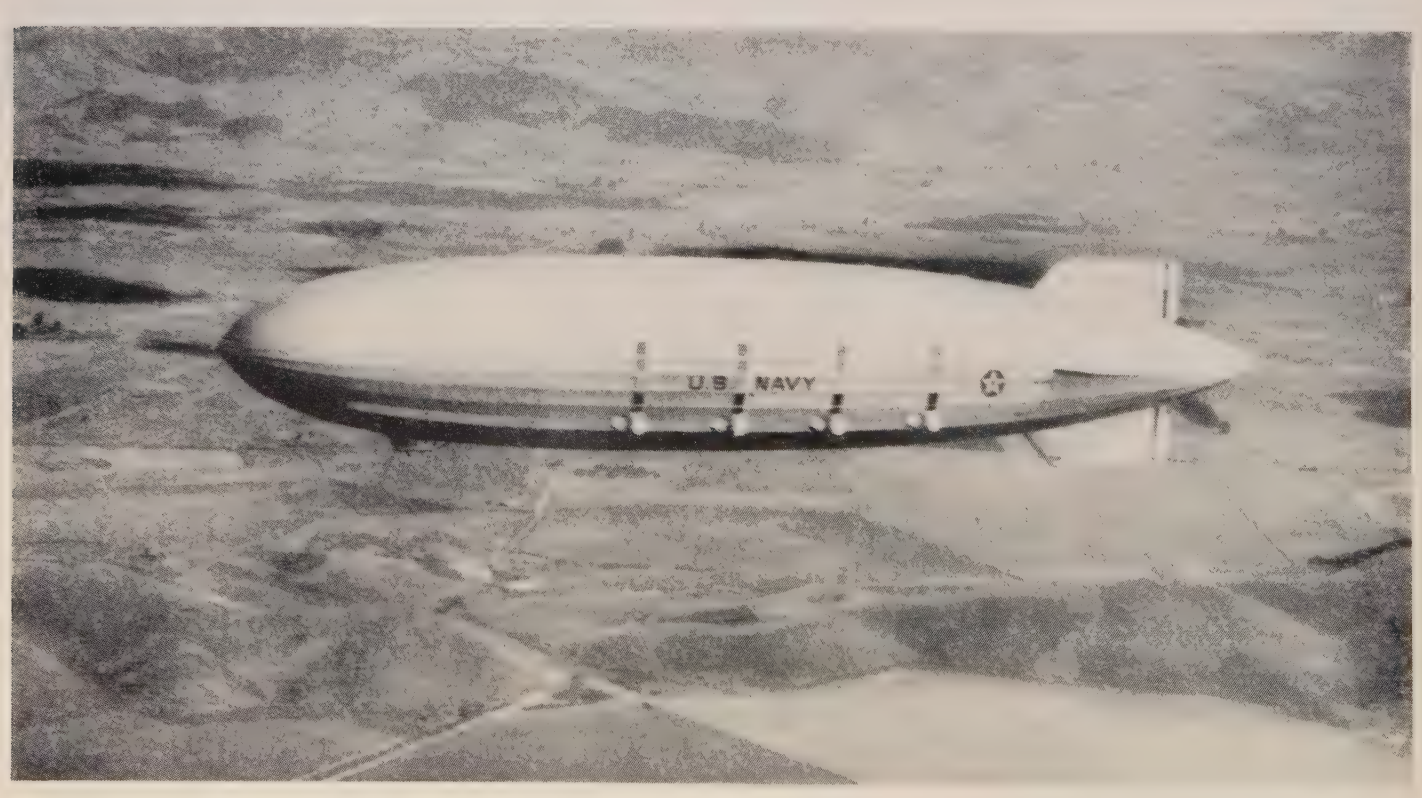



Pictured here is the USS Macon in flight over San Francisco Bay. Like the Hindenburg, the Macon crashed suddenly and caused Naval interest in airships to become dormant. (U. S. Navy photo)

## Lighter Than Air . . .

(*Continued from Page* 40)

Imperial German Army and Navy. The dirigible had come into its own as an aerial weapon. Great Britain was well aware of Germany's new air might. Several zeppelins were detected over English soil in early 1914 and the London dailies began clamoring for the hides of their ministers.

"Germany has evolved, at an immense trouble and expense, an aerial dreadnought which will remain in the air for four days and nights, will fly at a speed of 50 miles per hour, will carry several machine guns, and 2,000 pounds of incendiary equipment . . . in the past, the mistakes of the ministers have been retrieved and this country has muddled through: but with regard to a possible attack from the air (by dirigible), there will be no possibility of 'muddling through, and the disorganized and panic-stricken survivors of the population of London will have the sole, although sorry, satisfaction, before passing under German domination, of hanging the guilty ministers."

But as fate would have it, the hostilities of World War I saw extensive development given not to the airship, but to the airplane. The fast, prop-driven biplanes, served a much more useful tactical purpose, and although the dirigible was used by both sides, its effect on the outcome of the war was insignificant. With the cessation of hostilities, a new use was discovered for the airship. With excellent long-range characteristics, the dirigible was envisioned as the cargo and passenger carrier of the future, and after the war, there were numerous attempts to cross the Atlantic via the airship. The first attempt of note was the double crossing of the Atlantic in July, 1919, by the British H.M. Airship R.34. The great trip was accomplished under the command of Maj. George Scott, with a crew of 30, one stowaway, and a ship's cat. Full speed on five engines was 35 knots, and the policy was to "feel" the way across by meteorological reports passed by radio and by local observation. In addition, there was provided as a navigation aid, "an umbrella with the map of the heavens painted inside it and a metal dome pierced with holes of varying magnitude giving an accurate representation of the night sky." Three small boilers and a frying pan, using hot gas bled from the exhausts, enabled all hands to eat proper meals, and the only major crisis arose when some unknown felon stirred the officers' mustard with a toothbrush. The voyage was a master stroke of airmanship and navigation with the crew enjoying the unquestioned advantage of working space, slow cruising speed, a wide range of equipment, and near-nautical techniques.

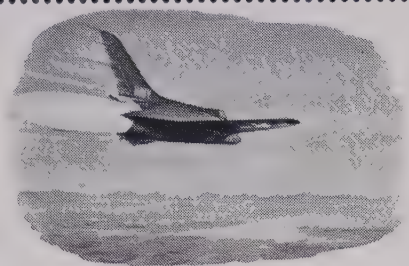
Although the United States laid claim to some of Germany's greatest airships as part of its war reparations, Zeppelin construction continued. In 1928, the Graf Zeppelin made the double crossing from Friedrichshafen to Lakehurst, N.J., covering 6,630 miles in 111 hours. In 1930, as a result of two serious crashes, the British halted their dirigible development. The Germans went on, however, and in 1933 even inaugurated a passenger service to South America with the Graf Zeppelin. At this time, there were no piston-engine airplanes which could even approach the almost fantastic long-range capabilities of the dirigible. German industrialists invited greater expansion of the airship program. But the year 1937 was approaching, and construction was in full swing on the Hindenburg—the ship which was to climax the fate of the airship for commercial travel.

The blimp, or non-rigid airship, serves as en excellent defensive weapon. As shown here, the careful positioning of blimps around the LSTs prevents an effective strafing attack by enemy airplanes. (U. S. Navy photo)

The Hindenburg was a monster of an airship, and it was the first designed specifically for commercial travel. It was 814 feet long, had a maximum diameter of 135 feet, and had a gas volume of 7,062,951 cubic feet. It was built by the Luftschiffbau Zeppelin Works of Freidrichshafen. Structurally, the Hindenburg was a masterpiece, and German engineers associated with the project were highly praised for the professional touch of artistry which has never been equaled in dirigible construction. Truss girders made up of light metal section were used. The hull was divided by ring frames into separate compartments in which the gas bags were accommodated, the load being taken up by the keel which also provided communication between one end of the ship and the other. There were 15 main transverse-ring frames spaced about 49 feet apart along the length of the ship. These frames were 36-sided polygons, to each corner of which longitudinal girders were fixed. The rings were fitted with supplementary stiffening frames on their inner sides to which bracing wires were fastened. These wires ran out radially from the "spine" of the ship, and were deflected by the supplementary frames before reaching the main frames, so that only alternate corners of the latter were in tension. Two auxiliary frames were placed between the main frames, bringing the total number of frames to 45. Passenger accommodations were exquisite. The huge gondola built into the lower keel held 150 people in two separate decks. Plush lounges and sleeping quarters were provided.

The Hindenburg was originally designed to utilize helium with only a small amount of hydrogen for ballast contained in bags within the helium containers. However, in a famous controversy with Secretary Ickes, the German government was refused the sale of helium which is quite abundant in the United States. Hydrogen was the only resort. It was a tragic decision.

The Hindenburg made several successful Atlantic crossings. As the ship approached the mooring mast at Lakehurst, May 7, 1937, the entire craft exploded, burned, and fell in one of the most tragic disasters of modern times. Passengers leaped from the gondola and fell earthward as crowds of horrified spectators stood by helplessly. The explosion was later attributed to an electrical discharge from the atmosphere in the vicinity of a hydrogen leak. In one gigantic blaze, the history of commercial travel by dirigible came to an end. No country has ever taken up further development, and the commercial airliner put the seal on the grave of lighter-than-air transport.



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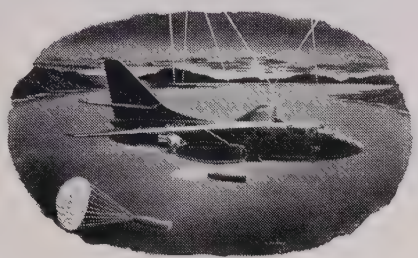

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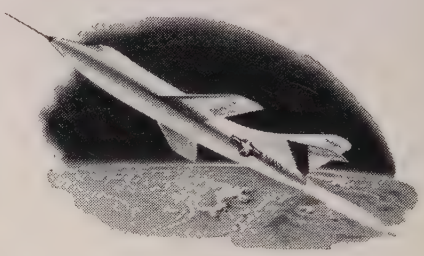

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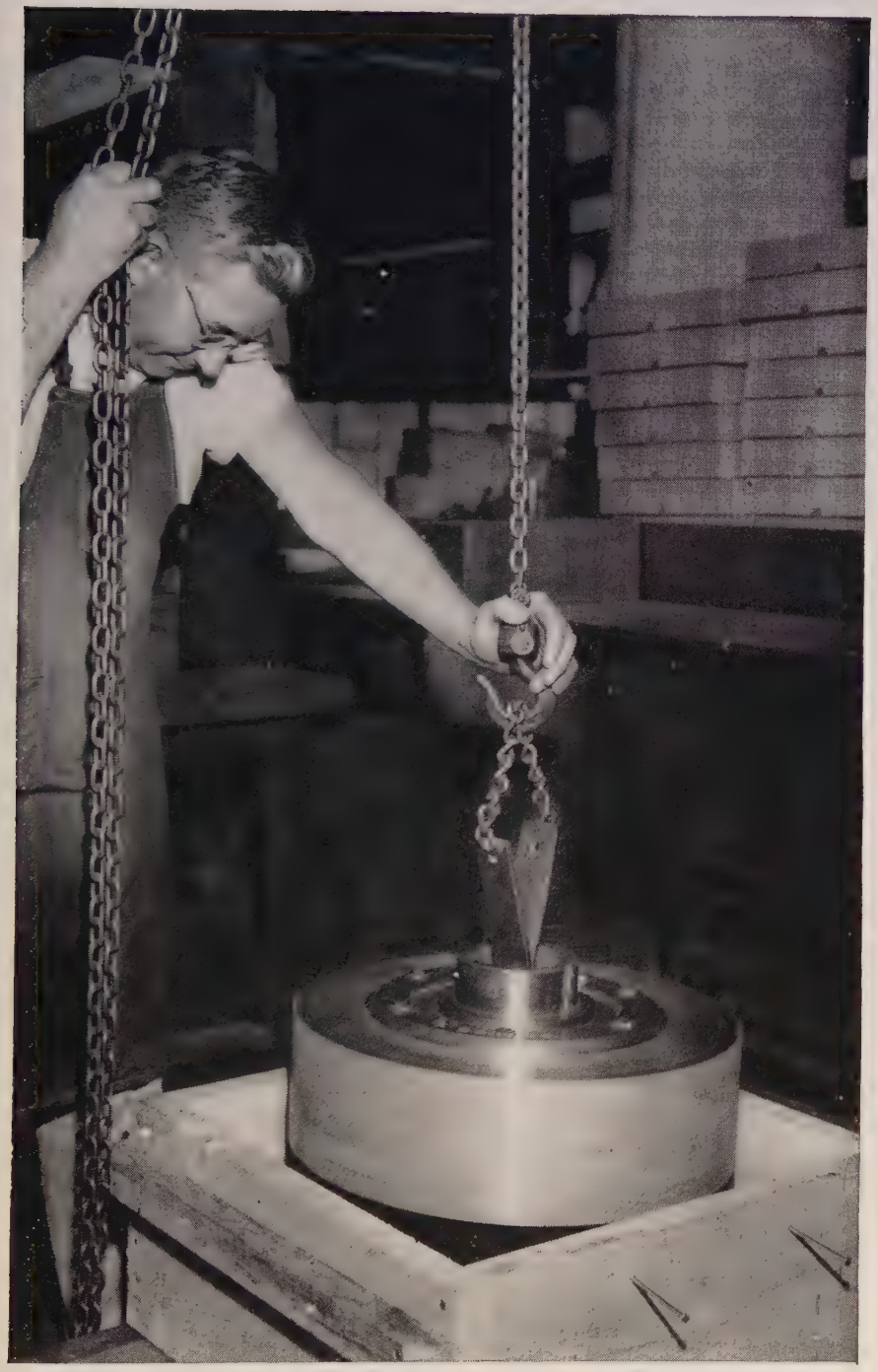

**$25,000 Norton Diamond** grinding wheel for a prominent ceramics manufacturer. It is designed for precision centerless grinding of extremely hard ceramic parts for the textile and electronics industry. Not typical in price — but typical of Norton Company's ability to meet all kinds of grinding problems.

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But whether you are or not . . . "the best of grinding equipment" and accessories will be in some measure a party to product success in almost any industrial endeavor you undertake.

## About diamond wheels . . .

Norton Company's diamond wheels have been called the "Crown Jewels" of industry. Norton was the first to introduce each type of diamond wheel — resinoid, metal and vitrified bonded . . . does all its own sizing, grading and laboratory checking of diamonds . . . duplicates wheel specifications with constantly controlled accuracy.

Norton makes grinding wheels of all types, a wide range of precision grinding and lapping machines . . . and in addition is active in the fast-growing and wide field of high temperature refractories. It is a company leading toward the future . . . for itself, its customers and its own people.

## Planning your future

To young men now planning ahead, a career with Norton offers exceptional opportunities in many interesting fields . . . some already explored, others still in the pioneering stage — but all calling for continuous research and product development. If you have the necessary college technical training and wish to investigate the openings now available at Norton, write to us. Please include complete details. Address Director of Personnel, Norton Company, Worcester 6, Mass.

NORTON

*Making better products . . . to make your products better*

# SKIMMING INDUSTRIAL HEADLINES

by Richard Bauer, M. E. '59

## Photography in Science

High-speed cameras that record as high as 15 million picture frames a second have been developed by the Eastman Kodak Research Laboratories.

Camera units having film wrapped on a revolving drum, or based on a rotating mirror principle, utilize high-intensity, short-duration exposure to reach almost fantastic recording speeds. Other cameras, with conventional film sprocket drive, are capable of speeds up to about 10,000 frames per second.

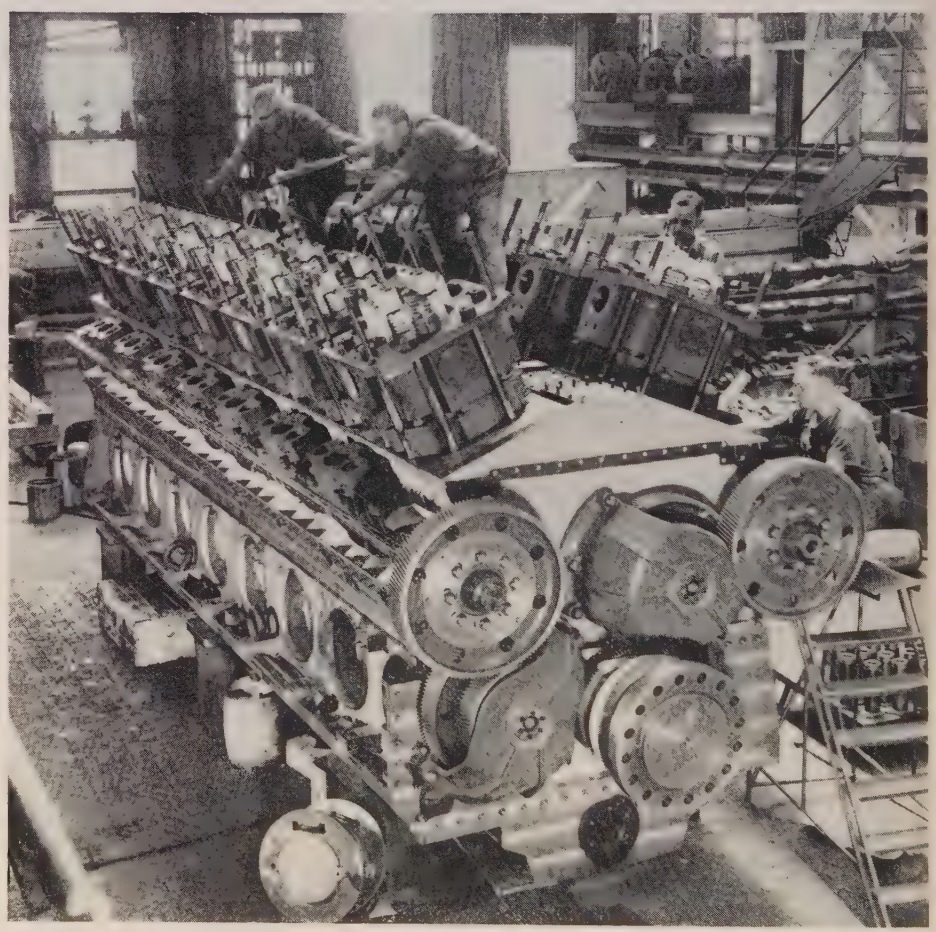
High-speed movies are finding increasing applications in science and industry, he noted. Some of these uses are measurement of mechanical and electrical effects, determination of velocities, study of welding arcs, and analysis of fundamental chemical processes. They are also proving useful in the study of combustion processes and explosive reactions, including guided missile, rocket, and atomic bomb research. One superfast camera, the Hycon Submicrosecond, has an exposure time of one ten-millionth of one second. It is used to study particle motion in blast furnaces and jet engine combustion.

The numerous current applications of photographic materials and techniques in science and engineering can be divided into three classes: photo reproduction, photo recording, and photo analysis.

Examples in the reproduction class are the various photocopy, drawing reproduction, and microfilming methods, including such new uses as the Kodak Minicard system. This recently announced system provides a means for storage and selection of both digital and graphic information in a single recording medium. It combines the high storage capacity of microfilm and the abilities for manipulation of the punched card.

Data recording includes numerous uses of both conventional and special camera equipment to obtain photographs for records of construction progress, experimental apparatus, equipment development, and time and motion studies. For example, the paper industry uses photography to determine the amount of pulpwood in stacked piles. A camera is set up with its lens perpendicular to the log ends. After photography, a photoelectric scanner notes differences in the negative density of log ends and the spaces between the logs, and gives a direct measurement of the wood in cubic feet.

In the category of photo analysis, various photography methods had their beginnings in research laboratories, then were streamlined to become invaluable production control tools. Photography



New Turbo-supercharged Vee Engine, SW 14, in production at Worthington's Buffalo Works, for a Western power plant. New engine is capable of ratings up to 5,000 horsepower. Massive, heavy duty gear train appears in foreground, followed by cam follower guides. Deep cylinder heads were especially designed for maximum cooling and streamline gas flow. Oversized access doors are for easier preventive maintenance and inspection. Engine also features 5-inch heavy camshaft and removable cylinder liners with cast-in water jackets.

Hughes-equipped T-29 "flying laboratory" for systems evaluation.

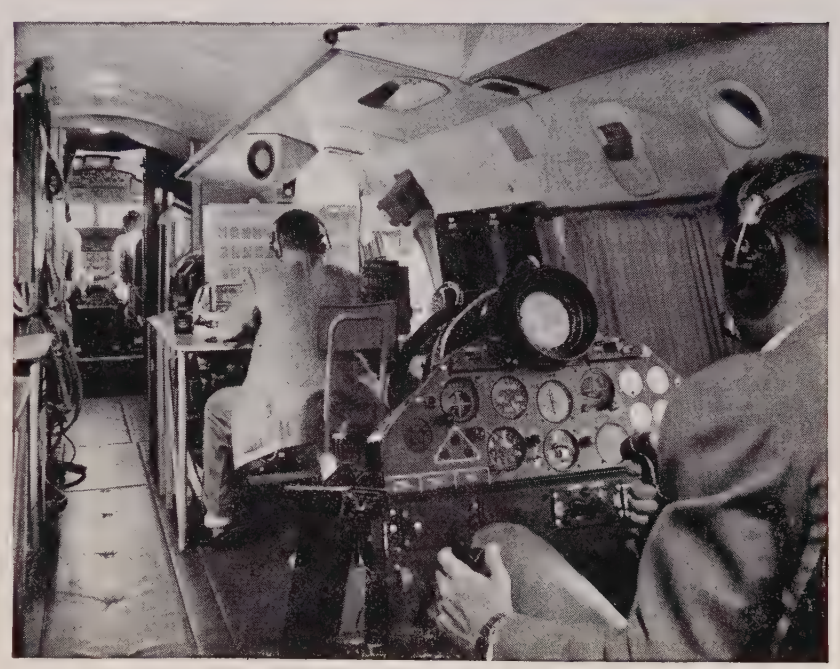
*Flight evaluation of advanced interceptor electronic system uses unique approach.*

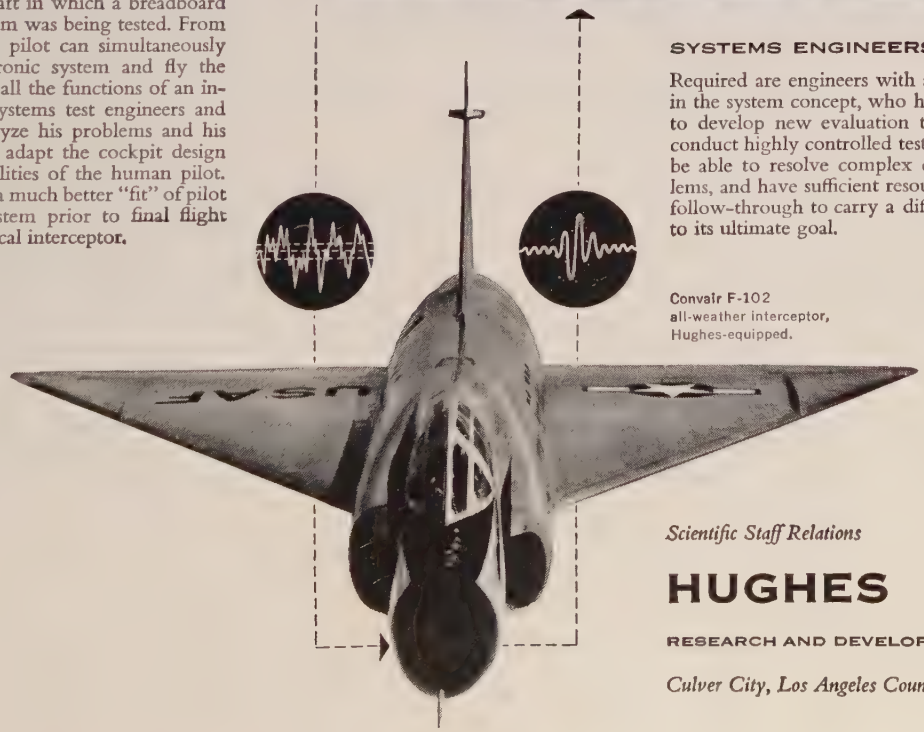
# T-29 "INTERCEPTOR"

THE DEVELOPMENT OF AIRBORNE ELECTRONIC SYSTEMS REQUIRES THOROUGH FLIGHT EVALUATION OF BREADBOARD AND PROTOTYPE EQUIPMENT PRIOR TO FINAL DESIGN. AT HUGHES, SYSTEMS FOR INTERCEPTORS ARE FIRST TESTED IN "FLYING LABORATORIES" IN WHICH THE EQUIPMENT IS READILY ACCESSIBLE TO SYSTEMS TEST ENGINEERS

One interesting problem recently confronting Hughes engineers was that of evaluating the requirements imposed upon the pilot of a high-speed one-man interceptor. This arose in the development of a new integrated electronic system to control several phases of an all-weather interceptor's flight. Because of the great importance of providing the pilot with the optimum design and arrangement of displays and controls, it became necessary to determine accurately the pilot's work load during flight, and the human factors that affect his ability to carry out his task.

The solution was to install a complete mock-up of the actual interceptor cockpit in a large T-29 aircraft in which a breadboard model of the system was being tested. From this cockpit a test pilot can simultaneously operate the electronic system and fly the T-29, performing all the functions of an interceptor pilot. Systems test engineers and psychologists analyze his problems and his performance, and adapt the cockpit design to the natural abilities of the human pilot. The result will be a much better "fit" of pilot and electronic system prior to final flight testing in the tactical interceptor.





Convair F-102 all-weather interceptor, Hughes-equipped.

### SYSTEMS ENGINEERS

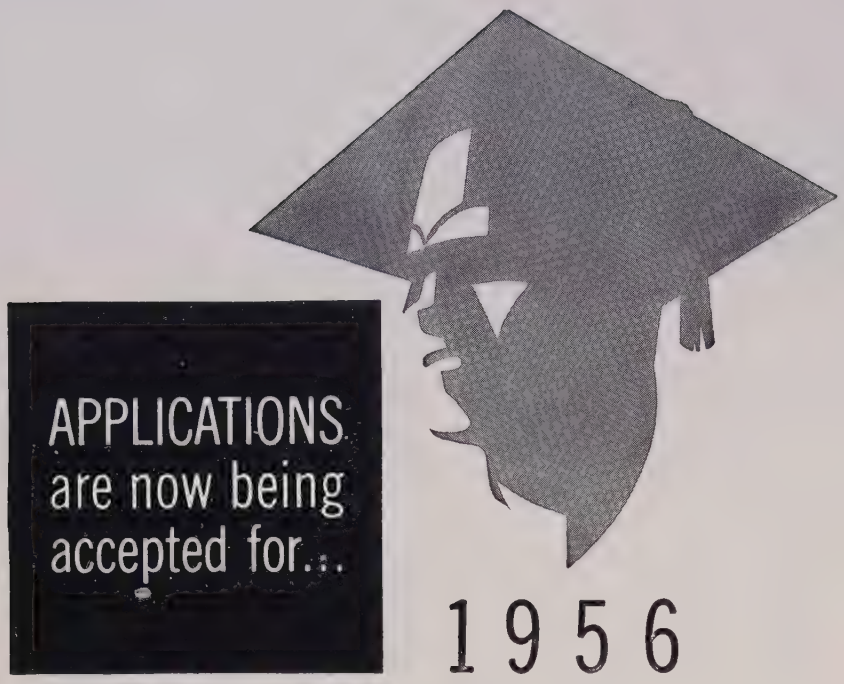
Required are engineers with a basic interest in the system concept, who have the ability to develop new evaluation techniques and conduct highly controlled tests. They should be able to resolve complex circuitry problems, and have sufficient resourcefulness and follow-through to carry a difficult program to its ultimate goal.

*Scientific Staff Relations*

## HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

*Culver City, Los Angeles County, California*




1956

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| | |
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| Experimental Physicists | Analytical Chemists |
| Nuclear Physicists | Inorganic Chemists |
| Theoretical Physicists | Physical Chemists |
| Mathematicians | Mechanical Engineers |
| Metallurgical Engineers | Electrical Engineers (Electronics) |

**Summer employment opportunities at the Laboratory are open to approximately 100 graduate students majoring in various physical sciences, and undergraduates receiving their degrees next June who intend to continue their advance studies.**

**The program provides for well-paid summer work with renowned scientists in one of the nation's most important and finest equipped research laboratories.**

**Summer employees will become familiar with several phases of vital scientific research and development activity related as closely as possible to the individual's field of interest. This experience will enable students to appraise the advantages of a possible career at the Laboratory.**

**In addition to interesting work, employees will enjoy delightful daytime temperatures and blanket-cool nights in a timbered, mountainous area, only 35 miles from historic old Santa Fe.**

**Interested students should make immediate inquiry. Completed applications must be received by the Laboratory not later than February 1, 1956, in order to allow time for necessary security clearance. Applicants must be U. S. citizens.**

**Mail inquiry to:**
**Department of Scientific Personnel**

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provides the record for subsequent analysis in:

X-ray diffraction—a method of studying the internal atomic or molecular structure of crystals;

photoelectric stress analysis—a means by which an engineer can solve problems of stress distribution;

photomicrography and metallurgy—used in the study of metal alloys and similar materials;

electron microscopy, which reveals structural characteristics invisible with the light microscope.

Some analytical problems cannot be solved without photography because the photographic emulsion is the only medium capable of recording invisible radiations. An outstanding example is the recording of the tracks or paths of some types of nuclear particles resulting from the bombardment of atoms in cyclotrons or similar equipment.

The speed of these paritcles in air is reduced by the stopping power of the gelatin emulsion to a point where their path of progress is revealed by a developed silver image. Microscopic examination then provides such data as the angle of penetration and the length of the path, from which the energy of the particle and then the identification of the particle itself can be determined.

## Electronic Traffic Signals

Last month Chicago's Mayor Richard J. Daley pushed a button throwing radio controlled and electronically mechanized traffic signals into operation at thirteen busy street intersections.

The radio traffic control system, believed to be the first of its kind in the world, was designed and built for Chicago by the General Electric Company.

Chicago's request to the Federal Communications Commission in Washington for a station license to transmit radio signals to co-ordinate traffic signals was so unusual that special authorization by the Commission was necessary before the City was granted permission to install the pilot system.

In a large city as Chicago vehicle movements and direction of travel on certain streets vary in volume from hour to hour and day to day. Traffic control signals, without interconnecting cable, cannot possibly cope with these changing traffic conditions and costly and bothersome delays result. Even with costly interconnecting cable, signal timing changes are limited. Radio coordination from a Central Station will provide traffic signal timing changes necessary to meet these variable traffic conditions and traffic will benefit substantially at a much lower cost than is possible with conventional underground cable.

(*Continued on Page* 56)

PAUL P. PERDUE

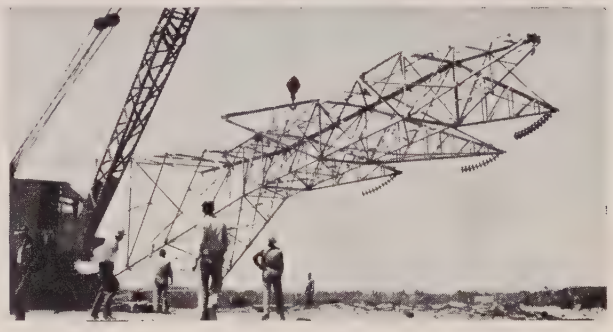
# "I'm glad that I chose WISCONSIN ELECTRIC POWER COMPANY"

After graduation from Iowa State College in 1948 with a BS degree in industrial engineering, Paul P. Perdue chose to begin his career as a Cadet Engineer in the Personnel Services Department of Wisconsin Electric Power Company. He later became a Job Analyst and then was promoted to Senior Job Analyst. Recently he became Assistant to the Superintendent of the Electrical Testing and Meter division. He says, "I'm glad I chose WEP Company. There's plenty of opportunity here!"

## THERE'S A PLACE FOR YOU IN OUR FUTURE!

Many engineering graduates choose Wisconsin Electric Power Company because of its reputation for sound and steady progress . . . for its modern and pioneering policies. For example, our power plants have established world records for efficiency. They were the first to develop and use the process of burning pulverized fuel, the first to introduce radiant superheaters into their furnaces. Engineering talents are needed in the varied fields of our operations. Recognition of ability is assured through an unique "management inventory" system which has received industry-wide attention.

**PLANNING** — Engineers are needed to help plan and design the generating, transmission and distribution facilities which serve the needs of more than half a million electric customers in Wisconsin and upper Michigan.



**CONSTRUCTION** — Engineers are needed to supervise the details of a continuing construction program. The 1955 construction budget for the Wisconsin Electric Power Company system amounted to more than 41 million dollars.

**SALES** — Engineers are needed for many phases of the Company's sales program. Openings are available in the field of industrial sales . . . in the activities of lighting, heating, air conditioning and commercial groups.

**ADMINISTRATION** — Engineers are needed for many activities which provide an excellent training for advancement into administrative fields. Many of our executive positions are now held by engineering graduates.

**Write to our PERSONNEL SERVICES DEPT. for a copy of our Annual Report and other information**

**WISCONSIN ELECTRIC POWER COMPANY**

231 West Michigan St., Milwaukee 1, Wisconsin

(*Continued from Page* 52)

The system includes a Central Control Station located at City Hall and a transmitter and antenna on the roof of the Board of Trade Building. The control station is linked to the antenna by existing underground cable.

Existing stop-and-go lights and standards at each intersection have been adapted to radio control by equipping them with antennas, receivers, decoders and electronic mechanisms. To regulate timing of traffic signals, the Central Control Station will transmit coded radio tones to all locations.

Radio receivers pick up the radio waves and decoders determine which messages are intended for each location. Immediately after intercepting messages, the decoder actuates the timing mechanism of traffic signals as directed by central control. Decoders respond only to messages designed by code for intersections at which they are installed. For example, a code directed to one particular street is ignored by decoders at all other locations. The most desirable signal timing is put into operation automatically each day, but it is modified as often as necessary to facilitate movement of traffiic. In bad weather, the system can be operated manually from the Central Control Station.

Chicago now has centralized traffic control in the loop district, operated by a cable system from a control room in City Hall. Loop traffic through 78 intersections will continue to be regulated by this means.

## Loudspeakers for Construction Projects

Loudspeaker systems, connecting the offices of construction companies with workers on the erection site, have solved the problem of communication between the man in the office and the worker on the girder.

At the New York Coliseum, for example, a well-planned loudspeaker system, which mushrooms as the job progresses, enables an operator at a central telephone switchboard to page to a nearby telephone any worker on the project. To contact his floor foreman, for instance, the office man picks up a phone and calls the job number—the operator pages the foreman to the nearest phone (located on every other floor), and in a few minutes the supervisor has his instructions.

According to the chairman of the operating committee for the joint-venture contractors working on the Coliseum, the loudspeaker system "not only provides excellent contact between the front offices and the job, but it also expedites the flow of materials." When a truckload of materials arrives at the project, the operator can announce what it is and where it is located—an extremely valuable aid in a job the size of the Coliseum.

The loudspeakers at the project are placed as soon as the steel is erected. At present, there are 128 speakers on the project from the foundation to the top floor. The speakers and their installation are estimated to cost between $7,000 and $9,000.

## Remote Control TV

Complete remote control operation of closed-circuit television cameras is provided by this unique "servo pan and tilt" system developed by Dage Television Division, Thompson Products, Inc. Designated the "285-A Servo System," it includes a multilens camera which is completely controlled by a separate monitor-console. Controls in the console allow three pre-set pan and tilt positions to be instantly selected by pushing a button, or completely free flexible manual control simply by turning an appropriate knob. The pre-set positions may be readily changed. Different colored knobs and push-buttons distinguish identity for clear and simple operation.

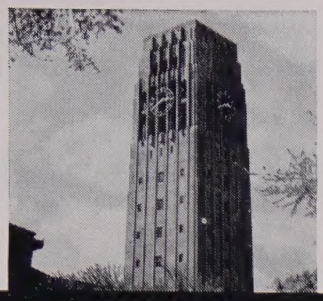
The remote control unit provides operator safety in hazardous locations, permits quick and accurate viewing of widely-spaced objectives, and assures undetected operation in security and surveillance installations. The camera may be mounted on a tripod or fixed in a permanent position.

---

A good speech is like a girl's skirt—it is long enough to cover the subject, and yet short enough to be interesting.

For tough and dangerous assignments in science and industry, Thompson Products has developed the "285-A" Servo System, a remote control two piece closed circuit television unit. The unit provides operator safety in hazardous positions and assures undetected operation in security and surveillance installations.

WISCONSIN



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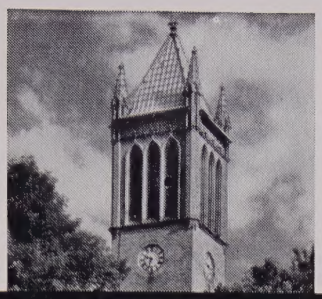

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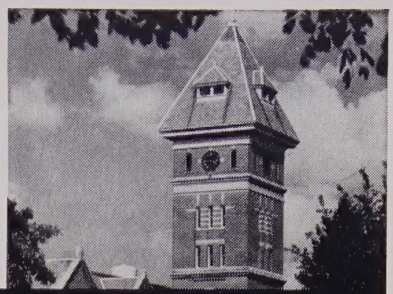

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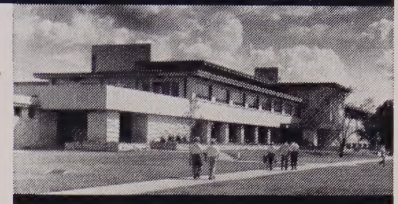
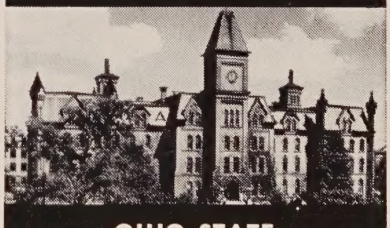


TEXAS A&M

ILLINOIS

PENN STATE

GEORGIA TECH



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# BRAIN TEASERS

by Larry Kiefling, M. E. '56

1. Man was born in the 19th Century. He was X years of age in the year $X^2$. What was his age in the year 1870?

2. The volume of a sphere is increasing at the rate of 16 cu. in. per second. At the instant when the radius is 6 in. how fast is it increasing?

3. Six pairs of twins belong to five families. The twins' names are: Jim and Bob, Ruth and Naomi, Henry and Harold, Frank and Jean, Martha and Mary, and Charles and Leslie. Their parents are the Merritts, the Nelsons, the Stearns, and the Stuarts, and Mrs. Morgan. From the clues given below, tell which twins belong to which parents.

a. Frank and Jean, and Charles and Leslie are fraternal twins.

b. Mrs. Morgan has taught second grade since Mr. Morgan died 15 years ago. Among her pupils is the Merritt's youngest boy and also Jim and Bob whom she cannot tell apart.

c. Ruth and Mary are sisters.

d. The Stearn twins date the Stuart twins for movies and dances. The twins are the Stearns' only children.

e. One of the Merritt twins looks like an older brother and the other one like a younger sister.

f. Frank is annoyed by all the attention his new baby brother receives.

g. Martha wears a gold bracelet and Mary wears a silver one to distinguish them.

h. Henry and Harold are Cub Scouts.

*(Hint: It is possible for a boy to look like his sister).*

4. Try this square root problem and tell us what digit each x represents.

```
      x x x
    ---------
√   xxxxxx
      x
    ---------
     xx3
     xxx
    ---------
      xxxx
      xx3x
```

5. A bear left its den and went due south in a straight line for one mile. Then it made a 90-degree turn to the left and walked another mile in a straight line. Twice more it made 90-degree turns to the left and walked a mile in a straight line, thus returning to its den. On reaching this starting point, the bear was facing south. What was the color of the bear.

6. Eight men entered a recent tennis tournament at Hillcreast. The tournament was played in 3 consecutive days, one round per day, and happily no match was defaulted. The first and second round matches were stipulated to be 2 sets out of 3, while the final match was 3 sets out of 5. A spectator who was present on all 3 days reported the following facts:

a. Eggleston never met Haverford.

b. Before play began, Gormley remarked to Bancroft, "I see that we meet in the finals."

c. Chadwick won a set at love but lost his first match.

d. Altogether 140 games were played, of which the losers won 43.

e. When the pairings were posted, Abercrombie said to Devereaux, "Do you concede, or do you want to play it out?"

f. On the second day, the first-round losers played bridge, and the same table gathered on the third with Eggleston in place of Abercrombie.

g. Bancroft won 9 games.

h. Franklin won 37 games.

i. The first score of the tournament was a service ace by Gormley, at which Eggleston shouted, "Hey, I'm not over there!"

Who won the tournament? Whom did he beat and by what score?

7. A stone is thrown horizontally at a speed of 100 feet per second, from a point in a boat 16 feet above the water. At what angle does the stone strike the water? (g. 32 ft./sec./sec.)

8. A quantity of m grams of Polonium disintegrates with an instantaneous rate of $5 \times 10^{-3}$ or 5/1000 *m* grams per day. Compute how much of an initial quantity of *m* grams of Polonium will be left after 100 days and what is the half life of Polonium?

---

SOLUTIONS

1. He is 64 years old.

2. 0.0354 in./sec.

3. Jim and Bob are the Nelson twins, Frank and Jean the Stuarts', Ruth and Naomi, and Martha and Mary belong to Mrs. Morgan, Henry and Harold are the Merritt twins, and the Stearn twins are Charles and Leslie (a girl).

4.

```
      3 4 4
    ---------
√ 118336
      9
    ---------
     64| 283
         256
    ---------
    684| 2736
        2736
    ---------
```

5. If the bear is headed south on reaching his den, and left it in a due south line, his den must be on the North Pole since the last leg of the trip was at right angles to the first leg. At the North Pole every direction in which the bear faces is due south. The bear must be a polar bear and must be white.

6. The minimum number of sets that could have decided the tournament was 15, totaling 90 games for the winners. The winners actually took 97 games (d). One extra set was played in the first round (c), leaving 1 game to be accounted for. One set in the whole tournament must have reached 5-all and must have been won at 7-5.

Bancroft lost his first match by 6-4 and 7-5 (g). Franklin reached the final, where he lost (h). Since he won the unique 7-5 set, his first round opponent was Bancroft.

Other first-round pairings were Abercrombie vs. Devereaux (e), and Gormley vs. Eggleston (i). The remaining two entrants must have been paired: Haverford vs. Chadwick.

The winners in the first round were Haverford (c), Franklin (h), Eggleston and Devereaux (f). In the second round Eggleston did not meet Haverford (a), nor did he meet Franklin, for Franklin vs. Bancroft and Eggleston vs. Gormley were in different halves of the original bracket (b). Therefore Eggleston met Devereaux and Haverford met Franklin. The winners were Devereaux (f) and Franklin (h). Devereaux won the final from Franklin by 6-4, -4, 6-4 (h).

7. The stone strikes the water at 17°45'.

8. After 100 days .6066m will remain, and the half life of Polonium is 138.62 days.

# Engineering is more than a department at the Timken Company—it's everything!

## *That's why we offer such a promising future for graduate engineers*

FEW companies can offer engineering and metallurgy graduates such a wide variety of opportunities as you will find within the Timken Company. And we are constantly seeking college graduates who have specialized in these fields because every phase of our manufacturing, research, and marketing requires advanced technical skills and training.

**PROMOTIONS MADE FROM WITHIN** There is an unusual opportunity for you to advance in the Timken Company. This is highlighted by the fact that one hundred percent of the men in executive and supervisory positions, including the president of the company, have risen from the ranks. And most of these key men are graduate engineers or metallurgists.

**MANY FINE TECHNICAL OPPORTUNITIES** The Timken Company offers a splendid opportunity to every graduate in one of the many specialized spheres of the company's operation. These include research and development in tapered roller bearings, alloy steel, and rock bits; production of fine alloy steel; metallurgical testing, quality control, and technical service; bearing design and manufacturing control; bearing application engineering for aircraft, automotive, agricultural, railroad, industrial, and other fields; rock bit design, forging, and heat treatment; and sales engineering, covering development work in every market where Timken bearings, steel, and rock bits are used or have a potential.

Another especially important part of engineering work at the Timken Company is the design of plants and specialized equipment for making Timken Company products better and faster. An outstanding example is our revolutionary new, completely automatic bearing plant now in operation in Bucyrus, Ohio.

**SOLVE PROBLEMS FOR ALL INDUSTRY** You can be assured of an interesting and stimulating career with the Timken Company because of the diversity of applications into which our products go. Every industry is a user of these products. That means that Timken Company engineers and metallurgists are constantly involved in solving problems and designing for new applications in fields far removed from their own drafting table or laboratory bench. We believe that this opportunity to play a part in the advancement of *all* American industry is an important reason why technically trained graudates like being on the Timken Company team.

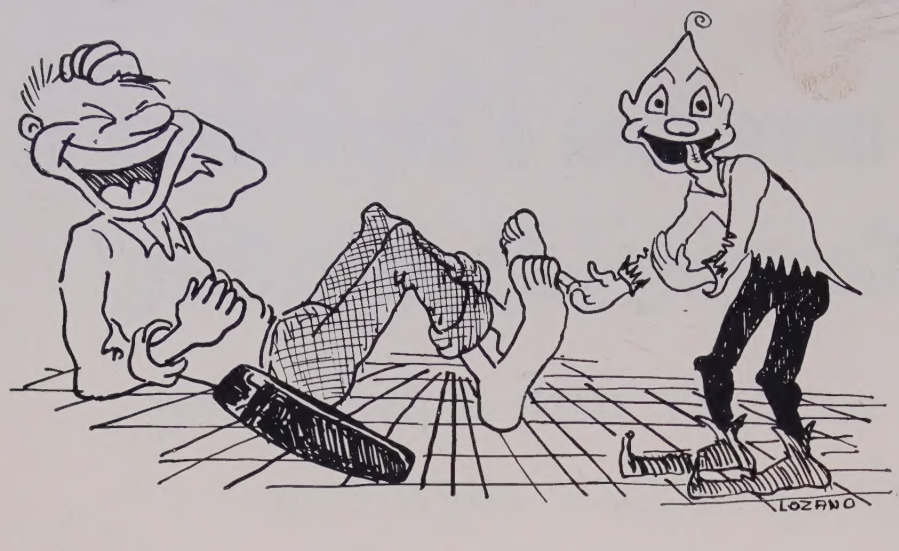
**RECORD OF PIONEERING, PROGRESS** The Timken Company was founded 56 years ago. Since then, it has grown to become the world's largest manufacturer of tapered roller bearings and removable rock bits, and a foremost producer of fine alloy steel bars, billets and seamless steel tubing. Our unique combination of experience and research has built an enviable reputation for solving difficult problems for our customers. By constantly expanding and strengthening our technical staff with aggressive and imaginative young engineers and metallurgists, we intend to continue our record of pioneering and progress. And if you possess the abilities and qualities we need, we'll be happy to have you share in that progress.

**SEND FOR MORE INFORMATION** For more detailed information about The Timken Roller Bearing Company, its training program, and the career opportunities for you, write to the college relations manager for your free copy of the booklet, "*This Is Timken*".

The Timken Roller Bearing Company

Canton 6, Ohio

TAPERED ROLLER BEARINGS • ALLOY STEEL & SEAMLESS TUBING • REMOVABLE ROCK BITS




# TECHNOCRACKS

A man was accustomed to walking through a rural cemetery on his way home since it was a short cut. One night he started through, unaware that a new grave, seven feet deep, had been dug in his path. He tumbled into the grave. For almost an hour he struggled to get out but finally gave up and decided to settle down for the night.

A gangly farmer, out on a possum hunt, came walking through the cemetery. He, too, fell into the grave. He began a desperate attempt to get out, unaware there was anyone else in the grave.

The first man listened to him silently for a few minutes, and then reached over in the pitch darkness and laid a hand on his shoulder.

"You can't get out of here," he said. But that farmer did!

* * *

Sign at AF base: Notice! Absolutely no flying permitted over nudist camp exactly 8.35 miles from the base on a true course of 190 degrees.

* * *

A chaperone is a force acting on a couple to maintain it in a state of equilibrium.

* * *

Thermometers are not the only things that are graduated and have many degrees without having any brains.

* * *

The professor has been lecturing to a very inattentive group: "Class dismissed, and don't flap your ears or bray on the way out."

* * *

Coroner: Were there any powder marks on the deceased?

Wife: Yes, that's why I shot him.

First Father—"Has your son's education proved helpful since you took him into the firm?"

Second Father—"Oh, yes, whenever we have a conference, we let him mix the cocktails."

* * *

A farmer and a professor were sharing a seat on a train. It was getting lonesome so the farmer started a conversation and they soon became a friendly pair.

"Let's have a game of riddles to pass the time," said the professor, "if I have a riddle that you can't guess you give me one dollar or vice versa."

"All right," replied the farmer, "but since you are better educated than I am, do you mind if I give you only fifty cents?"

"OK," replied the professor, "You go first."

"Well, what animal has three legs walking and two legs flying?"

"I don't know. Here's your dollar. What's the answer?"

"I don't know either. Here your fifty cents," answered the farmer.

* * *

Customer: "Your dog seems very fond of watching you cut hair."

Barber: "Naw, it's just that once in a while I snip off a part of the customer's ear."

* * *

Walking with a friend one day, a professor passed a large fish shop where a fine catch of codfish with mouths open and eyes staring were arranged in a row. The prof suddenly stopped, looked at them, and clutching his friend by the arm, exclaimed: "Heavens! That reminds me, I have a class in EE this hour."

## SINE OF LOVE

I saw her as a most beautiful conglomeration of ellipses, parabolas, and sine waves in perfect symmetery as she slithered into the living room. I sat confidently on the sofa sketching free body diagrams as she sat down beside me. I felt the firm pressure of her thigh against mine. I would judge its modulus of resilience to be about 0.034 in-lb. I felt her warm breath (approx. 102.4° F.) on my cheek as she said, "Have I kept you waiting long, Xerxes?" "Only 34 minutes and 16.2 seconds," I replied as I subconsciously estimated the tensile strength of her sweater to be at least 4000 psi. She ran her soft hand through my hair (generating some $3 \times 10^2$ statcouloumbs) and asked, "What did you bring me?" as she eyed the long object in my pants pocket . . . "Oh," I said quickly, "That's not for you, that's my slide rule," as I withdrew it and dramatically and adeptly flicked the ash from her cigarette with the slide. "Are all engineers as strong, calm, and romantic as you are, Zerxes?" I was mentally computing the acceleration of my heartbeat to be at least 14.7 thumps/sec$^2$. "Of course they are," I said as I thought—Engineers—Romantic?—Even I had learned in GE 711 that a woman is nothing but a slow moving man with a lower specific heat and a higher center of gravity . . . She might hypnotize some men with her curvilinear attraction, but not me—an Engineer!

I observed her coldly (114.7° F.). She leaned over and kissed me lightly—I glanced down at my lapel only to see a molten mass that had once been my Tau Beta pin. She watched in admiration as I casually put the lighted end of my cigarette in my mouth and blew the smoke from between my toes. . . . I rose with a masculine air of indifference and stalked from the room on my hands.

* * *

C.E. walking in a downtown store squeezed one doll and it yelled, "Mama!"

He tried another and it yelled, "Floorwalker!"

* * *

Soon after Janice and Montie were married, Janice decided to cook her first chicken. When Montie started to carve it, he said, "What did you stuff it with dear?"

"It didn't need stuffing, darling," she replied. "It wasn't hollow."

* * *

A girl and a engineer were listening to a chimes recital.

"Beautiful, aren't they?" said she.

"Pardon?" he inquired.

"I say, they're beautiful, aren't they?"

"I'm sorry," he roared, "but I can't hear a thing except those lousy bells."